BOOK OF ABSTRACTS

4th International Conference of Sciences "Revamped Scientific Outlook of 21st Century, 2025"

(RSO-21st Century)

November 12, 2025

Organized by

Rawalpindi Women University,
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4th International Conference: Revamped Scientific Outlook of 21st Century (RSO-21st. Century)
November 12, 2025

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ABOUT THE CONFERENCE

RSO-21st Century is organized every year at Rawalpindi Women University. This year's 4th International conference of sciences is being organized to recognize the rapid pace of technological advancements, globalization, and societal changes that have transformed the landscape of science, requiring a fresh perspective to tackle complex challenges including combating with infectious diseases, climate change and its global impact. RSO-21st Century recognises the multidisciplinary nature of science, as today's complex problems require integrated approach and insights from multiple disciplines of science including Botany, Chemistry, Zoology, Physics, Mathematics, Statistics, and Computer Science. Therefore, this platform invites scientists, researchers, industry experts, academicians, and policy makers to develop a shared understanding of the revamped scientific outlook that encompasses the interdisciplinary nature of modern science and fosters innovation, collaboration, and social impact. This platform provides a comprehensive approach that integrates multiple insights from diverse fields. Rawalpindi Women University is embracing this approach to fosters collaborations and develop holistic and sustainable solutions of this century. Hence, this conference welcomes all stakeholders from different disciplines and walks of life to come together to exchange ideas, share knowledge and work towards common goals including translating scientific knowledge to practical implications that benefits the society at large.

MESSAGE OF PATRON-IN-CHIEF

It is my great pleasure to welcome you to the 4th International Conference of Sciences "*Revamped Scientific Outlook of 21st Century, 2025*", being held on November 12, 2025. This Book of Abstracts represents the intellectual energy of our scholarly community faculty, researchers, students, and industry partners, who are united by a shared commitment to advance science for societal benefit.

At Rawalpindi Women University, we believe that the frontiers of knowledge are best moved through collaboration across disciplines. The breadth of contributions in this volumefrom Chemistry, Botany and Zoology to Mathematics, Computer Science, Information Technology and Statistics—speaks to a vibrant ecosystem in which foundational discovery meets application. The conference theme invites us not merely to celebrate current achievements, but to re-examine assumptions, modernise methods, and harness emerging tools—from high-throughput experimentation and omics to AI, data science, and advanced modelling—so that our science remains responsive to the grand challenges of the 21st century: climate resilience, sustainable food and energy systems, public health, and equitable digital transformation.

As Chairperson, All Pakistan Women Universities Consortium, I am especially proud that this forum foregrounds the leadership of women in science and innovation. Diversity in teams and perspectives is not an aspiration alone; it is a proven driver of research quality, creativity, and impact. I encourage our early-career researchers—particularly women and first-generation scholars—to use this platform to present boldly, question constructively, and network purposefully. The habits you cultivate here—rigour, openness, and ethical responsibility—will shape the future of Pakistan's knowledge economy.

My own journey in plant molecular biology and genetics—from Quaid i-Azam University to doctoral work at the University of Cambridge, and post-doctoral research at the University of North Carolina has taught me that scientific progress depends on three enduring values: clarity of question, integrity of method, and generosity of collaboration. I see these values reflected in the pages that follow. May they guide our deliberations throughout the conference and beyond, ensuring that our findings translate into resilient agriculture, greener chemistries, safer digital systems, and data-informed public policy?

I extend heartfelt thanks to our Scientific and Organising Committees. Reviewers, session chairs, volunteers, and institutional partners whose professionalism and dedication have made this conference possible. I am grateful to all contributing authors for entrusting us with your latest work, and to our sponsors and collaborators for their continued support.
I invite you to engage deeply with the programme—attend plenaries, contribute to thematic sessions, and explore posters with curiosity and care. Let this gathering be a catalyst for new ideas, durable collaborations, and tangible outcomes that uplift communities locally and resonate globally.

With warm regards and best wishes for an inspiring conference

Prof. Dr. Bushra Mirza (PoP, T.I.)
Vice Chancellor, Rawalpindi
Women University, Rawalpindi

KEYNOTE ADDRESS-I

The Integrator Engine: How 21st Century Mathematics Powers Sustainable Development through Convergence Science and Planetary-Scale Computation

Dr Norma Alias

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Mathematics has undergone a fundamental transformation in the 21st century, evolving from a collection of specialized disciplines to humanity's most powerful integrator engine for addressing planetary-scale challenges embodied in the Sustainable Development Goals (SDG). This keynote explores how modern mathematical convergence, spanning quantum field theory to global systems modelling, provides the computational and theoretical foundation essential for sustainable planetary stewardship in the Anthropocene with artificial intelligence (AI) serving as a critical accelerant. The presentation begins by examining recent breakthroughs in computational mathematics that have revolutionized our approach to complex systems. We highlight how machine learning-enhanced numerical methods now optimize renewable energy grids across multiple scales (Chen et al., 2023, Nature Energy), how quantum-inspired algorithms solve previously intractable optimization problems in resource allocation (Kumar & Zhang, 2024, Science Advances), and how topological data analysis reveals hidden patterns in climate and health datasets (Rodriguez-Martinez et al., 2022, PNAS). Central to this discussion is the concept of "mathematical convergence science" the unprecedented integration of pure theoretical advances with computational power to address real-world challenges. We demonstrate how recent developments in stochastic partial differential equations are transforming epidemic modeling for global health policy (Thompson & Li, 2023, Nature Medicine), how advances in computational fluid dynamics are enabling next-generation climate simulations for urban resilience planning (Patel et al., 2024, Journal of Computational Physics), and how mathematical ecology informed by category theory is revolutionizing biodiversity conservation strategies (Williams et al., 2022, Ecology Letters) as shown in Figure 2. The keynote showcases emerging mathematical frontiers essential for the SDGs: geometric deep learning architectures that capture multi-scale climate dynamics (Anderson & Park, 2023, Nature Climate Change), quantum computing applications in

sustainable chemistry (Johnson et al., 2024, Chemical Reviews), network science approaches to understanding social-ecological systems (Garcia & Smith, 2022, Science), and uncertainty quantification methods for long-term sustainability planning under deep uncertainty (Brown et al., 2023, Global Environmental Change).

We examine how mathematical education must evolve to prepare researchers for convergence science, emphasizing computational fluency, interdisciplinary communication, and ethical awareness in algorithm design. Recent studies show that interdisciplinary mathematical training significantly improves problem-solving capabilities for sustainability challenges (Lee *et al.*, 2024, Educational Studies in Mathematics). The presentation concludes with a vision of mathematics as the essential integrator engine of the 21st century, not merely solving individual problems but revealing the deep interconnections between SDGs and enabling holistic approaches to planetary stewardship. We argue that the most transformative mathematical discoveries will emerge at the intersection of theoretical depth and computational power, driven by the urgent need for sustainable solutions. With AI acting as an enabling force, SDG alignment reinforces mathematics as the primary integrator. This restructured abstract maintains the original's scientific rigor while strengthening AI relevance, and clarifying the hierarchy of mathematical innovation driving sustainable development.

Keywords: Mathematical Convergence, Epidemic Modelling

KEYNOTE ADDRESS-II

The Amazing Landscape of Science & Technology: Innovation for Progress

Atta-ur-Rahman FRS

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Science, technology and innovation are rapidly transforming the economies of those countries that are investing wisely in these fields. These fascinating changes range across many fields including materials engineering, biotechnology, artificial intelligence and neuroscience. Metamaterials have the amazing characteristic of bending light so that they can make objects covered with such materials invisible to the naked eyes! Devices have been developed that restore partial eyesight to the blind through images that can be transferred through the nervous system of the tongue to the brain. Anti-ageing compounds are being developed that slow down the process of ageing. Graphene has been developed which is 200 times stronger than steel and it is finding many applications. 3D printing is now being used to print parts of living human organs such as liver and kidneys. Artificial intelligence is developing at a very rapid pace and finding its way in a myriad applications, ranging from city traffic management to drug discovery, from stock exchange appraisals to new drug development.

An excellent beginning was made by Pakistan during 2000-2008 when I was Federal Minister of Science and Technology/Chairman Higher Education Commission (HEC). These have led to an unprecedented growth in high quality research publications in Pakistan. The establishment of the Pakistan Education and Research Network (PERN) in 2004 brought a revolution by providing free access of 65,000 textbooks and 25,000 international journals to students, teachers and researchers. Thousands of our brightest students were selected and sent abroad for training at PhD and post-doctoral levels to leading universities of the world in USA, UK, Germany, France, Sweden, Australia and Austria. The world's largest Fulbright program was initiated with 50% of the funds being invested by Pakistan. New entrepreneurial universities are being established and Pakistan has taken important steps to transition to a technology driven knowledge economy. Some of these developments will be described.

Keywords: Science, Technology, 3D printing

MESSAGE BY GUEST OF HONOUR (INAUGURAL SESSION)

It gives me immense pleasure to extend my warmest greetings to the organizers, participants, and contributors of the workshop "*Revamped Scientific Outlook of the 21st Century*" organized by Rawalpindi Women University. This initiative reflects a commendable commitment to advancing scientific thought, innovation, and research excellence in Pakistan.

The 21st century is an era defined by rapid technological evolution and interdisciplinary exploration. To remain relevant and impactful, our scientific community must adopt forward-looking approaches, integrate modern tools, and foster collaborative research cultures. Such academic gatherings play a vital role in inspiring young researchers, broadening perspectives, and aligning scientific inquiry with the needs of our society.

I sincerely appreciate the efforts of Rawalpindi Women University in providing a platform that encourages intellectual exchange and critical thinking. I am confident that this workshop will stimulate meaningful discussions, generate innovative ideas, and strengthen our collective resolve to contribute to a knowledge-based economy.

I wish the organizers and participants great success in their endeavors and look forward to witnessing the transformative outcomes of this initiative.

Prof. Dr. Hassan Sher
Vice Chancellor
University of Swat

MESSAGE BY CHIEF GUEST (CONCLUDING SESSION)

Thank you for the invitation to the 4th International Conference of Sciences "*Revamped Scientific Outlook of 21st Century, 2025,"* on November 12, 2025. Conferences matter when they change what we do on Monday morning. This gathering has that potential.

Pakistan needs science that is excellent, connected, and useful. Excellent—because rigor is non-negotiable. Connected—because solutions emerge where chemists meet biologists, where mathematicians work with computer scientists and statisticians, and where universities listen to industry and government. Useful—because public investment in research must return value in health, food systems, energy, environment, and secure digital infrastructure.

At the Pakistan Science Foundation, our focus is simple: enable talent, reward quality, and shorten the distance from idea to impact. That means competitive, transparent funding; shared facilities that raise the baseline for everyone; and partnerships that turn prototypes into products and pilots into policy.

A request to authors and students: be precise about the problem you are solving, the evidence that supports your claims, and the pathway to scale. Build teams that cross boundaries. Document your methods so others can reproduce and extend your work.

My appreciation to Rawalpindi Women University and the organizing teams for a well-run platform. May the conversations today turn into proposals, projects, and products that strengthen Pakistan's knowledge economy.

Prof. Dr. Mohammad Akmal
Chairman, Pakistan Science Foundation
Rawalpindi Women University

MESSAGE OF THE HOD: BOTANY

It is a great honor for me to welcome you to 4th International Conference on the "*Revamped Scientific Outlook of the 21st Century 2025*"at Rawalpindi Women University where we come together to explore an improved scientific impact of current advancements. This is an era defined by rapid and groundbreaking discoveries, and unprecedented challenges. Today, more than ever, science holds the power to shape the future of humanity, offering solutions to the global issues we face from climate change and health crises to technological evolution and sustainability.

The 21st century has seen science become more interdisciplinary, inclusive and driven by data than ever before. New frontiers in artificial intelligence, Plant biotechnology, and environmental science have transformed how we understand the world and address its complexities. Department of Botany in this spirit of transformation and forward-thinking presents the plants, as the foundation of ecosystems in combating climate change, regulation of our atmosphere, stabilization of our soils and provision of sustenance to life on Earth. Yet, with habitats under threat and ecosystems rapidly changing, our work as scientists, conservationists, and policy makers is more vital than ever. Our goal at this conference is not just to reflect on the changes that have brought us to this point, but to envision the future we can collectively create. Together, we have the ability to redefine the role of science in society making it more accessible, innovative and impactful.

I would like to extend my deepest thanks to our esteemed speakers, presenters and all those who have worked tirelessly to bring this event to life. Your dedication to advancing scientific thought and fostering a culture of collaboration is what makes this conference a success.

As we embark on this journey of discovery and discussion, I encourage each of you to take full advantage of the opportunity to share your ideas, challenge established norms, and envision the endless possibilities that lie ahead. At the end I pray that may this gathering inspire new thinking, foster meaningful connections, and ignite the scientific revolution of the 21st century.

Dr. Yamin Bibi
Associate Professor, Botany
Rawalpindi Women University

MESSAGE OF THE HOD: CHEMISTRY

Dear Colleagues and Esteemed Participants, On behalf of the Chemistry Department, I am delighted to welcome you to our 4th International Conference on "*Revamped Scientific Outlook of 21st Century, 2025*". Building on success of last three conferences this gathering becomes our premier event which brings together brilliant minds from various fields of chemistry, fostering collaboration and innovation that can lead to groundbreaking discoveries in science.

All abstracts and proposals submitted reflect diversified scientific ideas and research findings which add a rich content of various disciplines of chemistry to this abstract book. Chemistry is at the heart of many scientific disciplines, and we are excited to explore the intersections of scientific ideas through interdisciplinary approach.

We extend our heartfelt gratitude to all contributors, reviewers and presenters/participants for their precious contribution in making this conference a successful event. During this conference, we will engage in stimulating discussions, share insights, and forge connections that transcend our individual disciplines.

This conference serves as a vibrant platform for exchanging progressive ideas and promoting sustainable research practices. It provides a platform for young researchers, academicians, and professionals to present their innovative ideas, learn from experts, and gain exposure to global trends in chemical sciences. Through this exchange of knowledge, we aim to nurture curiosity, encourage critical thinking, and build a strong network that continues to support research excellence beyond this event.

I encourage each of you to actively participate, ask questions, and share your expertise. Together, we can inspire and generate new ideas and approaches that will propel our research and its impact on our community positively.

Thank you for being a part of this exciting journey and I look forward to an inspiring conference ahead.

Prof. Dr. M. Zaman Ashraf
Professor, Chemistry / Editor RSO-2025
Rawalpindi Women University

MESSAGE OF THE HOD: COMPUTER SCIENCE

It gives me immense pleasure to welcome you all to the *4th International Conference of Sciences – Revamped Scientific Outlook of the 21st Century, 2025*, organized by the Department of Computer Science, Rawalpindi Women University. This event marks another milestone in our continuous journey of promoting excellence in research, innovation, and knowledge exchange across diverse scientific domains.

The conference serves as a vibrant platform where ideas meet innovation, and research meets real-world impact. By bringing together a distinguished community of scholars, practitioners, and students, we aim to encourage cross-disciplinary collaboration that addresses the grand challenges of our time, ranging from sustainability and digital trust to AI-driven social good and inclusive technological transformation.

At RWU, we believe that scientific progress must be rooted in empathy, inclusivity, and responsibility. The themes of this year's conference embody this belief by emphasizing the role of technology in creating a greener, safer, and more equitable world. I am confident that the dialogues, discoveries, and partnerships emerging from this conference will inspire transformative solutions and long-term academic collaborations.

I extend my sincere appreciation to our esteemed keynote speakers, session chairs, scientific committee members, organizers, and all participants for their valuable contributions. Your dedication and enthusiasm are the driving forces behind the success of this event.

May this conference ignite curiosity, strengthen research networks, and inspire a shared vision for shaping the future of science and technology.

With best wishes for a successful and intellectually rewarding conference experience.

Dr. Amber Sarwar
Assistant Professor, Computer Science
Rawalpindi Women University

MESSAGE OF THE HOD: IT

It gives me immense pleasure to extend my heartfelt congratulations to the organizers, participants, and distinguished guests of the 4th Conference on "*Revamped Scientific Outlook of 21st Century*", held at Rawalpindi Women University. This conference serves as a vital platform for researchers, academicians, and students to exchange innovative ideas, showcase scientific advancements, and foster interdisciplinary collaboration.

The Department of Information Technology takes pride in contributing to this intellectual endeavor that encourages creative thinking and research excellence. Events like these not only strengthen academic linkages but also inspire our young scholars to pursue knowledge that addresses real-world challenges through innovation and technology.

I commend the organizers for their dedication and efforts in promoting a culture of research and knowledge dissemination. I wish all participants great success and a rewarding experience throughout the conference.

Dr. Muhammad Bilal
Assistant Professor, Information Technology
Rawalpindi Women University

MESSAGE OF THE HOD: MATHEMATICS

On behalf of the Mathematics Department, I am delighted to welcome you to our 4th International Conference on "*Revamped Scientific Outlook of the 21st Century (RSO-2025)*".

The scientific landscape of the 21st century is profoundly shaped by mathematics, which fosters collaboration, innovation, and deeper understanding across diverse fields. Embracing this revamped scientific outlook not only enhances our collective knowledge but also empowers us to address future challenges and build a more sustainable world.

The valuable contributions presented in this abstract book stand as a testament to the dedication and hard work of our contributors, reviewers, presenters and participants. We sincerely appreciate their commitment, which continues to enrich the field of Mathematics and serves as an invaluable resource for the academic and research community.

We extend our heartfelt gratitude to all contributors, reviewers, presenters, and participants for their invaluable efforts in making this conference a success.

Thank you for being part of this exciting journey. I look forward to an inspiring and intellectually stimulating conference ahead.

Prof. Dr. Saima Mustafa
Professor, Mathematics
Rawalpindi Women University

MESSAGE OF THE HOD: STATISTICS

It is my pleasure to welcome you to the 4th International conference of Sciences on "*Revamped Scientific Outlook of 21st Century, 2025*". It is an honor to bring together leading statisticians, researchers, and professionals from across the globe to discuss innovations, challenges, and future directions in the field of statistics.

This conference serves as a platform to share knowledge, exchange ideas, and inspire progress in the application of statistics to solve complex problems in diverse fields, from healthcare and environmental science to artificial intelligence. The vast amounts of data generated today provide us with an unprecedented opportunity, but they also demand refined methods, rigorous analyses, and innovative approaches. At this conference, we will explore these challenges and collectively seek solutions that uphold the integrity and impact of our field.

Together, let us make the most of this opportunity to collaborate, learn, and build a stronger statistical community. Thank you for joining us, and I look forward to the impactful insights and partnerships that will emerge from this gathering.

Dr. Saba Riaz
Assistant Professor, Statistics
Rawalpindi Women University

MESSAGE OF THE HOD: ZOOLOGY

It gives me immense pleasure to extend a warm welcome to all distinguished guests, researchers, scholars, and students participating in this 4th *International Conference on Revamped Scientific Outlook of 21st Century, 2025*. The Department of Zoology takes great pride in being part of this meaningful endeavor that brings together brilliant minds from diverse scientific disciplines to share insights, innovations, and ideas shaping the future of research.

Science today is not confined within traditional boundaries. It thrives on collaboration and critical thinking. This conference embodies those very principles by providing a platform for dialogue, discovery, and dissemination of knowledge. I am confident that the exchange of ideas during the sessions in conference will inspire new directions in scientific inquiry and foster lasting academic partnerships across borders.

I wish the organizers and participants every success in making this conference a memorable and impactful event. May it serve as a milestone in our collective journey toward promoting a scientific outlook and advancing the frontiers of knowledge.

Thank you all for joining this conference at Rawalpindi Women University.

Warm regards,

Dr. Samina Qamer
Associate Professor, Zoology
Rawalpindi Women University

MESSAGE OF THE CONFERENCE COORDINATOR

Following months of meetings, meticulous checklists, and countless inter-department emails, I am delighted to welcome you to the 4th International Conference of Sciences, taking shape today on November 12, 2025. This Book of Abstracts captures the breadth and depth of inquiry that defines our multidisciplinary ethos bringing together scholars from Chemistry, Botany, Zoology, Mathematics, Computer Science, and Statistics to explore ideas that advance knowledge and translate into societal impact.

As Conference Coordinator, I have had the privilege of facilitating the many moving parts that make a forum like this possible—aligning with ORIC, coordinating with the Organizing and Scientific Committees, and working closely with the focal persons across departments to streamline submissions, reviews, scheduling, and communication. My sincere thanks to our reviewers for their thoughtful evaluations, to session chairs for shaping rigorous dialogue, and to our administrative and technical teams whose diligence ensures a seamless experience for authors and attendees.

To all contributors: thank you for entrusting us with your latest research. To our partners and sponsors: your support enables inclusive participation and high-quality programming. And to every participant: please engage fully—attend plenaries, explore posters, ask precise questions, and cultivate collaborations that endure beyond the conference day.

Wishing you a stimulating and rewarding experience.

Dr. Nazia Asghar (PhD, Chemistry)
Conference Coordinator - RSO 2025
Rawalpindi Women University

PREFACE

In the current scenario of increased population and industrialization, there is a dire need to address the issues of modern world through research. Towards expanding its engagements related to Research and Development, Rawalpindi Women University, Rawalpindi is going to organize the 4th International Conference on "*Revamped Scientific Outlook of 21st Century*" (RSO-21st Century) on November 12, 2025. The systematically designed conference themes will provide a wide array of professionals and students to come together with their visions for a better world. The diverse conference themes ranging from climate change to environmental hazards, pharmacology to fluid dynamics, biochemistry to photocatalysis, fresh water biology to wildlife management, cryptography to numerical analysis, and biodiversity to genetics sought collaborative efforts of all stakeholders at both national and international level. In this spirit, the conference organizers aim to brainstorm ideas and come up with solutions to minimize the adverse impact of various challenges of the modern world.

Our chief organizer, worthy Vice Chancellor of Rawalpindi Women University; Prof. Dr. Bushra Mirza envisioned to organize multidisciplinary conferences and gathering great minds in one place to discuss their latest research findings and collaborate to solve the trials of the modern world together. The connections between researchers and academicians through this conference will open new avenues of research and development fostering benefit of mankind. We welcome all the participants and dignitaries to Rawalpindi Women University. We are also thankful to our sponsors specially PHEC, PASTIC, PSF, RaysTech, Alpha-genomics and Bestway cement for their support in making this event successful.

Dr. Motsim Billah
Director ORIC/Conference Secretary
Rawalpindi Women University

ABOUT PASTIC

Pakistan Scientific & Technological Information Centre (PASTIC) is a subsidiary organization of Pakistan Science Foundation (PSF), under the umbrella of Ministry of Science and Technology (MoST). PASTIC is a specialized premier organization in the field of S&T information handling and dissemination responsible for catering to information needs of R&D and industrial community across the country. The PASTIC National Centre is housed at Quaid-e-Azam University Campus, Islamabad having a network of 6 Sub-Centres at Karachi, Lahore, Peshawar, Quetta, Faisalabad and Muzaffarabad.

To begin with PASTIC supported research community across the country when S&T research infrastructure in Pakistan was at a nascent stage and provided facilities including supply of scientific and technical documents, abstracts and indexes, bibliographies, translations, patent information and patent indexes, science reference library service, technological information transfer service, dissemination of computer-based information services, reprographic and publication services.

For further details visit: www.pastic.gov.pk

PASTIC Objectives

- Development of National Scientific & Technological Information (STI) resources (databases)
- Dissemination of Scientific & Technological Information through contemporary reference information tools
- Collaboration & Cooperation with institutional libraries/repositories for resource sharing
- Promotion of R&D based industrial development
- Printing of S&T/R&D Publications
- Capacity/skill development of researchers, information professionals, innovators & entrepreneurs
- Development of collaborations with national and international information networks

PASTIC Functions

S&T Publications

- *Technology Roundup:* Publish bi-monthly bulletin by repackaging of latest global Trade and Technology information.

- *Abstract Books of Conferences:* PASTIC supports publication/printing of Abstract Books of Conferences organized by various S&T universities (on request).

PASTIC Online databases

- *Pakistan Science Abstracts (PSA):* Abstracts of research published in Pakistani S&T Journals & Conference Proceedings etc.
- *National Digital Archive (NDA):* Full text digital repository of National Journals
- *PakCat:* Union Online Public Access Catalogue (OPAC) of books available in Scientific & Technological Libraries of Pakistan
-
- *Directory of Scientific Periodicals of Pakistan*: An index of scientific periodicals (e.g., Journals, Magazines etc.) published in Pakistan.
- *Digital Repository of Indigenous S&T literature*
- *Database of R&D Projects executed in Pakistan*
- *Database of Books published by Pakistani authors*
- *National Scientists Directory (NSD)*
- *Industry related databases* (e.g., Industries, Industrial challenges etc.)

Promotion of Commercializable Technologies & Industrial Products

Organize STEM and IT Expo for promotion of local R&D, SMEs, technologies/products/services, as well as empowering youth and general public on new and faster ways of delivering and accessing information.

National Science Reference Library Facility

A state-of-the-art Traditional Library facilitating the researcher through following services: Reference & Referral Services; Reader Service; Internet Service, Journal Listings; Photocopying & Scanning Services.

Skill Development/Capacity Building

Organize Seminars/Workshops /Trainings/ for capacity building of:

- Young Researchers on Data analysis, Reference Management etc.
- Women Entrepreneurs on E-marketing & E-business skills
- Library Professionals on Library automation & digitization
- Journal Publisher/Editors on E-Journal management & publishing
- Researchers and Innovators on Intellectual Property Rights, Media Information Literacy

CONFERENCE PROGRAM

08:00-09:00	**Registrations**
09:00-09:15	**Guests to be seated**
09:15-09:30	**Arrival of Chief Guest**
09:30-10:40	**Inaugural Session**
09:30-09:35	**Recitation from Holy Quran**
09:35-09:40	**National Anthem**
09:40-09:50	**Welcome Address by** *Prof. Dr. Bushra Mirza (PoP, TI), VC, RWU*
09:50-10:10	**Keynote Address:** *Prof. Dr. Norma Alias, Dept. of Math. Sci., UTM, Malaysia*
10:10-10:30	**Keynote Address:** *Prof. Dr. Axel Klein, University of Cologne, Department of Chemistry, Institute for Inorganic Chemistry, Cologne, Germany*
10:30-10:40	**Remarks by Guest of Honor:** *Prof. Dr. Hassan Sher, VC, University of Swat, Khyber Pakhtunkhwa*
10:40-10:50	**Remarks by Chief Guest:** *Hon'ble Mr. Rana Sikandar Hayat, Minister for Higher Education Punjab, Lahore*
10:50–10:55	**Shields Distribution to the Chief Guest & Keynote Speakers:** *Prof. Dr. Bushra Mirza (PoP, TI), VC, RWU, Rawalpindi*
10:55-11:00	**Group Photo**
11:00–11:30	**Tea Break**
11:30-13:30	**Morning Parallel Sessions** Session IA: Botany (**Fatima Hall**) Session IB: Botany (**Room 281**, 1st Floor, Sheikh Rasheed Block) Session IA: Chemistry (**CS-273,** 1st Floor, Sheikh Rasheed Block) Session IB: Chemistry (**Room 274,** 1st Floor, Sheikh Rasheed Block) Session IA: CS (**CS-293,** 2nd Floor, Sheikh Rasheed Block) Session IB: CS (**CS-307,** 3rd Floor, Sheikh Rasheed Block) Session IA: IT (**Room 294,** 2nd Floor, Sheikh Rasheed Block) Session IB: IT (**Room 296,** 2nd Floor, Sheikh Rasheed Block) Session IA: Mathematics (**CS-286,** 2nd Floor, Sheikh Rasheed Block) Session IB: Mathematics (**Webinar Room,** Sheikh Rasheed Block) Session IA: Stat (**Room 300,** 3rd Floor, Sheikh Rasheed Block) Session IA: Zoology (**ORIC Conference room**) Session IB: Zoology (**QEC conference room**) **Posters Display**
13:30-14:30	**Botany** *(Fatima Hall back side)* **Chemistry** *(Corridor,2nd Floor, Sheikh Rasheed Block)* **Zoology** *(Corridor, A Block)*

13:30-14:30	**Lunch & Namaz Break**
	Evening Parallel sessions
14:30-16:30	Session IIA: Botany (**Fatima Hall**)
	Session IIB: Botany (**Room 281**, 1st Floor, Sheikh Rasheed Block)
	Session IIA: Chemistry (**Room 274,** 1st Floor, Sheikh Rasheed Block)
	Session IIA: CS (**CS-293,** 2nd Floor, Sheikh Rasheed Block)
	Session IIA: IT (**Room 294,** 2nd Floor, Sheikh Rasheed Block)
	Session IIB: IT (**Room 296,** 2nd Floor, Sheikh Rasheed Block)
	Session IIA: Mathematics (**CS-286,** 2nd Floor, Sheikh Rasheed Block)
	Session IIB: Mathematics (**Webinar Room,** Sheikh Rasheed Block)
	Session IIA: Statistics (**Room 300,** 3rd Floor, Sheikh Rasheed Block)
	Session IIA: Zoology (**ORIC Conference room**)
	Session IIB: Zoology (**QEC conference room**)
	Panel Discussion
16:30-17:00	**Prof. Dr. Muhammad Mushtaq (T.I.) (Botany),** *QAU, Islamabad*
	Dr. Abdul Hameed (Chemistry), *PAEC, Islamabad*
	Prof. Dr. Sumaira Kausar (CS), *Bahria University*
	Dr. Muhammad Adnan (Information Technology), *Air Uni. ISB*
	Dr. Farkhanda Afzal (Mathematics), *MCS-NUST, Islamabad*
	Prof. Dr. Muhammad Aslam Asadi (Statistics), *BZU, Multan*
	Prof. Dr. Naeem Tariq Narejo (Zoology), *Uni. of Baltistan, Skardu*
17:00-18:00	**Concluding Ceremony**
17:00-17:15	**Concluding Remarks by Chief Guest**
	Prof. Dr. Muhammad Akmal, Chairman, PSF, Islamabad
17:15-17:25	**Concluding Remarks by Chief Organizer:**
	Prof. Dr. Bushra Mirza (PoP, TI), VC, RWU, Rawalpindi
17:25-17:40	**Sheild & Certificate distribution**
17:40-18:00	**Tea for distinguished guests**

ABSTRACTS
INVITED
SPEAKERS

BOTANY

Transforming Agricultural Education for Resilient Food Systems: Integrating Agroecology, Innovation, and Community Empowerment

Erdogan E Hakki

University of Selcuk, Konya Campus Türkiye

Future food systems are increasingly challenged by environmental pressures such as climate variability, dwindling natural resources, and accelerating biodiversity loss. These issues threaten global food security and demand a fundamental shift in how we cultivate, manage, and sustain agricultural ecosystems. To build resilience and sustainability, it is essential to empower future generations with the knowledge and skills needed to optimize biological resource use and adapt to changing ecological conditions. This abstract presents a synthesis emphasizing the need for transformative agricultural education that integrates interdisciplinary approaches. It advocates for the convergence of agroecological principles, digital innovations such as precision farming and remote sensing, and participatory, community-focused pedagogies. By fostering systems thinking and ecological literacy, these frameworks can cultivate a new cadre of professionals equipped to design, implement, and manage sustainable farming systems. Moreover, education that bridges scientific knowledge with traditional practices and stakeholder engagement can accelerate the transition to agroecosystems that are both productive and regenerative. The synthesis underscores that such holistic educational reforms are not merely supplementary but foundational to addressing the complex challenges of future food systems. A renewed focus on education, innovation, and community collaboration is thus pivotal for ensuring long-term food system resilience.

Keywords: Future food systems, Challenges, Agroecological principles, Resilience, Sustainability

Diversity of Wild Food Plants in Malakand and Hazara Diviosins: Implications for Food Security and Biodiversity Conservation

Hassan Sher, Zahid Ullah, Ahmad Ali

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The local inhabitants of Malakand and Hazara divisions (Shangla, Batagram, Swat, Dir, Chitral, Buner, Kohistan, and Manshera districts) residing in mountainous forested valleys consume a variety of wild food plants (WFPs) as part of their diet during growing seasons of the year. This tradition is centuries old and is attributed to the agro-pastoralist life style, poverty, lack of agricultural land and lack of diversity in agriculture-based food. Traditional knowledge of WFPs is of vital significance in the context of food security, erosion of genetic diversity, climate change, agricultural expansion, and change in socio- economic setup of the rural communities. In order to explore the possible role of WFPs in future food security and increasing magnitude of options choices broadening of food basket

Therefore an ethnobotanical study was conducted during spring 2025 in selected districts to document the botanical diversity, habitat, seasonality, traditional methods of recipes, and threats to WFPs. In total 50 key informants were interviewed using semi structured interviews, walk in the wood and focus group discussions. In total 60 WFPs species belonging to forty-five genera and thirty families were documented. These included two ferns, two mushrooms and 56 angiosperm species. Rosaceae was the dominant family with twelve species, followed by Fabaceae (5 species), Moraceae and Lamiaceae (4 species, each), and Polygonaceae (3 species). *Rubus* (3 species), *Berberis, Lathyrus, Vicia, Rumex, Pyrus, Prunus, Malva,* and *Ziziphus* with 2 species each were dominant genera in the area. The WFPs on the basis of habit were categorized as 27 herbs, 15 trees, 11 herbs, 2 mushrooms and 2 ferns. Fruits were the most consumed part (47%), followed by leaves (19%) and whole plant (9%). The most highly cited wild food plants included *Drypteris juxtaposita* (Kwanjay), *Nasturtium officinale* (Thalmerra), *Diplazium esculentum* (Ladora), *Medicago polymorpha* (shpeshtay), *Rubus ellipticus* (Goraj), *Berberis lycium* (kwaray). The folk knowledge attached to them is remarkable in the region, although declining among the younger generations. The recorded species needs to be re-evaluated in local projects aimed at fostering indigenous strategies of food security, as well as re-evaluating cultural heritage and sustaining small-scale food market circuits. These WFS are further recommended for nutritional and elemental analysis for the safety and efficacy of utilization.

Keywords: Wild Food Plants, Documentation, Indigenous strategies, Conservation, Future food security

Hemp A Botanical Blessing or Societal Menace? Unraveling Its Potential for Sustainable Development in Pakistan

Rahmatullah Qureshi

Department of Botany, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

Hemp (*Cannabis sativa* L.) one of the oldest domesticated crops known to humankind, stands today at the crossroads of controversy and opportunity. Historically cultivated for its multifaceted uses ranging from food, fiber, and medicine to paper and rope, this remarkable plant is native to Central and South Asia, including the tribal belts of Pakistan, Xinjiang, and parts of Mongolia and Siberia. With over 50,000 reported industrial, nutritional, medicinal, and environmental applications, hemp has emerged as a strategic crop that aligns remarkably well with the United Nations Sustainable Development Goals (SDGs), contributing simultaneously to People, Planet, and Profits. Despite its association with psychoactive compounds in cannabis, industrial hemp varieties possess minimal levels of THC, making them non-psychoactive and highly suitable for regulated cultivation. Globally legalized in over 50 countries, hemp supports sectors such as nutraceuticals, bio-construction, textiles, green energy, and phytoremediation. This presentation highlights pioneering research undertaken at the Institute of Hydroponic Agriculture, Rawat (PMAS-AAUR) using four native hemp germplasm accessions. The initiative marks a significant

step toward exploring Pakistan's potential in hemp-based green economy, rural uplift, and climate resilience. The study contextualizes hemp's role not only as a botanical treasure but as a powerful economic driver, especially in arid and semi-arid ecosystems. By removing stigma, developing science-based policy, and fostering public–private partnerships, hemp can be a cornerstone of sustainable development in Pakistan. This discourse repositions hemp from the margins of controversy to the center of innovation turning a perceived menace into a national blessing.

Keywords: Hemp, Strategic crop, Science-based policy Hemp-based green economy

Recent Developments in Omics Techniques for Improving Plant Abiotic Stress Using Microbes

Muhammad Naseem

University of Wurzburg, Germany

Farmers could not obtain substantial crop yields due to varying biotic and abiotic stress factors. Microorganisms can effectively cope with abiotic stressors, such as heavy metals, heat, and cold, and biotic stressors, such as pests and diseases. However, before utilizing microbes to alleviate these stresses, conducting a comprehensive investigation of indigenous microbial communities' ecology, evolution, and operation through omics methodologies is crucial. Powerful tools for understanding the complex interactions between microbes and plants are provided by omics approaches, opening the door to creative ways to increase plant resistance to abiotic stress. This review is to investigate how omics technologies are revolutionizing knowledge of plant–microbe interactions, which are essential advancing sustainable agriculture, and to collectively provide information on different microbial omic approaches such as genomic, transcriptomic, proteomic, metabolom ic, genome editing, and bioinformatic information about microbes to manage biotic and abiotic stress in plants. Additionally, the review will explore integrating multiple forms of omics techniques within a unified framework. The goals of the current review of omics technique s to enhance plant resilience to abiotic stress through the use of microbes are to further knowledge of the interactions between plants and microbes, make it easier to create successful microbial-based interventions, and eventually help to improve global food security in the face of environmental challenges and climate change. Through the application of various omics techniques, researchers can improve plant resilience to abiotic stress in agricultural systems, identify potential microbial candidates for enhancing stress tolerance, and obtain insights into the molecular mechanisms underlying plant–microbe interactions.

Keywords: Stresses, Food security, Stress alleviation, Microorganisms, Enhancing stress tolerance

Novel Plant Genetic Resources for Crop Improvement and Climate Resilience

Tariq Mahmood

Department of Plant Sciences, Quaid-i-Azam University, Islamabad, Pakistan

The strategic deployment of novel plant genetic resources is increasingly recognized as a cornerstone in addressing the interlinked challenges of global food security, climate change adaptation, and sustainable agricultural development. Genetic narrowing in modern commercial cultivars through extensive breeding and monoculture has drawn attention to underutilized species, wild relatives, landraces, and native plants for systematic exploration. These genetic reserves carry novel alleles with different resistance responses to biotic and abiotic stresses, improved nutritional status, and phenotypic plasticity that is expressed under extreme environmental conditions. Recent advancements in molecular genetics, high-throughput genomics, and precision biotechnology have significantly expedited the identification, functional annotation, and introgression of beneficial traits. Certain techniques such as genome-wide association studies (GWAS), marker- assisted selection (MAS), genomic selection (GS), and CRISPR-Cas- mediated editing of the genome will make it possible for elite germplasm to be enhanced targeting specific genes to produce cultivars with a better yield potential, stress resilience and nutritional quality. The integration of multi-omics approaches such as genomics, transcriptomics, proteomics, and metabolomics can give a holistic view of complex trait architecture and regulatory networks, leading to a fine- scale dissection of genotype-environment interactions. The systems biology perspective will further mainstream the expansion of crops' genetic bases while reducing vulnerability to the new emergence of pathogens, pests, and extremes of climate. On top of that, the careful application of new genetic diversity sustains agrobiodiversity conservation and enables ecologically sustainable and socially equitable food systems. Multidisciplinary collaborations among molecular biologists, plant breeders, conservationists, and policymakers are imperative for the establishment of dynamic conservation frameworks and equitable access to genetic resources. Other important integrative strategies are critical to engineer resilient cropping systems to sustain future global food production.

Keywords: Plant genetic resources, Stress Responses, Integration of multi-omics, Precision biotechnology, Dynamic conservation

Assessing Forest Cover Dynamics in the State of Azad Jammu And Kashmir: A Spatio-Temporal Analysis from 1990 to 2020 using Remote Sensing and GIS

Hamayun Shaheen

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Forest ecosystems are crucial for the sustainability of the Himalayan region owing to immense ecosystem services and ecological functioning. It is vital to monitor the ecosystem health and overall changes in forest cover to ensure environmental sustainability of any region. Remote Sensing technology (RST) and Geographical Information System (GIS) are robust and efficient tools to investigate forest cover change using GIS. Current study aimed to address the critical need for a

comprehensive understanding of the afforestation and deforestation dynamics in the state of Azad Jammu and Kashmir (AJK). The research objectives include determining forest cover, assessing vegetation density using Normalized Vegetation Index (NDVI), and analyzing the spatio-temporal changes in AJK's forest cover using ArcGIS 10.8 and ENVI 4.7. In this study, we have used the Landsat data for the detection of forest cover change from 1990 to 2020, using 1990 as a base year. Each satellite image was classified into three land cover categories, and post-classification implemented to analyze and interpret change detections. The GIS analysis has revealed that the Re and Afforestation/deforestation equation for the state of AJK is highly tilted towards deforestation as almost 2 times more area has undergone forest loss over the last 3 decades. The cover of the primary forests of the state have undergone a -11.4% change for 3 decades as compared tochange for 3 decades as compared to <5% increase in ReAfforested area. GIS analysis also revealed a highly significant increase in the barren land area as well as the built area causing severe forest loss. Historical data suggests that the earthquake of 2005 had immensely devastating impacts on the forest cover of Muzaffarabad division which comprises about 71% of the total state forest. However, the NDVI analysis indicated a significant increase in the private/rural forest cover linked with the socioeconomic transformations in the region. This comprehensive assessment of forest cover dynamics in AJK provides valuable insights for sustainable natural resource management, supports conservation initiatives, and lays the groundwork for evidence-based policy recommendations. The study underscores the importance of balancing development with habitat conservation to ensure sustainability of AJK's forests.

Keywords: Forest ecosystems, Geographical Information System, Satellite image, Socioeconomic transformations

AI-Powered Nanoinformatics in Plant Biotechnology: Integrating Artificial Neural Networks and Nanotechnology for the Next Scientific Frontier

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The convergence of Artificial Neural Networks (ANNs) and nanotechnology, empowered by artificial intelligence (AI), is opening new frontiers in plant biotechnology. This emerging interdisciplinary field—AI-powered nanoinformatics, enables the design, simulation, and prediction of nanoscale interactions within plant systems with unprecedented precision. By leveraging the pattern recognition and predictive capabilities of ANNs, researchers can optimize the development of plant-compatible nanomaterials for targeted gene delivery, smart nutrient systems, and early detection of plant stress or disease through nanosensors. AI-driven nanoinformatics also enhances the analysis of complex biological datasets, facilitating breakthroughs in plant genomics, metabolomics, and phenotyping. This integrated approach accelerates crop improvement,

supports climate-resilient agriculture, and fosters sustainable practices by enabling data-driven decision-making. As AI and nanotechnology continue to evolve, their combined application in plant sciences is poised to redefine how we understand, manipulate, and benefit from plant biology, marking a transformative shift in the future of agricultural biotechnology.

Keywords: Artificial Neural Networks (ANNs); Nanoinformatics; Plant Biotechnology; Artificial Intelligence (AI); Smart Agriculture

CHEMISTRY

Inorganic Hybrid Materials for Hydrogen Production

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Water splitting, a promising energy conversion technology, has gained attention for producing clean hydrogen fuel. The process involves two crucial reactions, namely the hydrogen evolution reaction (HER) and the oxygen evolution reaction (OER), necessitating cost- effective catalysts. Non-precious-metal catalysts, especially those derived from metal-organic frameworks (MOFs), show potential applications due to their high specific surface area (SSA) and efficient synergistic interactions. Thus, developing MOF-derived catalysts are crucial for advancing commercial water-splitting applications. This presentation will include the significance of electrochemical water splitting for hydrogen production and the synthesis of some innovative materials for this purpose. For instance, a novel core-shell structure is prepared, wherein MOFs serve as the core material with dispersed Ni and NiTe nanoparticles. Combining MOFs and NiTe in a core-shell configuration offers several synergistic and surface interface effects, leading to exceptional bifunctional activity for HER and the oxygen evolution reaction OER. A few other examples of the current work will be presented. By addressing the challenges of environmental pollution and energy sustainability, this research has the potential to be a valuable opportunity for the advancement of economically viable, efficient, and low over potential electro catalysts that facilitate the overall process of water splitting along with wastewater treatment.

Keywords: Metal-Organic Frameworks, Water Splitting, Hydrogen Production

Application of multivariate Chemometric techniques on spectroscopic data obtained from the analysis of food, plant and fuel samples

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The application of multivariate Chemometric techniques on spectroscopic data obtained from the analysis of food, plant and fuel samples enhanced the visibility of hidden information in the data sets. Principal Component Analysis (PCA) is a standard multivariate data analysis exploration tool was used to reduce the

dimensionality of spectroscopic data to visualize the pattern of grouping based on similarities and dis-similarities in the data set. The procedure of PCA is based on converting a set of correlated variables into a new set of uncorrelated variables called principal components. PCA redistributes the total variance of the data set in such a way that the first principal component has maximum variance, followed by second component and so on. PLS-DA is another technique was used to optimize separation between different groups of samples, which is accomplished by linking two data matrices X (i.e., raw data) and Y (i.e., groups, class membership etc.). The method in fact is extension of PLS. This approach aims to maximize the covariance between the independent variables X (sample readings; that is spectra) and the corresponding dependent variable Y (classes, groups; that is to say the targets that one wants to predict) of highly multidimensional data by finding a linear subspace of the explanatory variables. This new subspace permits the prediction of the Y variable based on a reduced number of factors (PLS components, or what are also known as latent variables). These factors describe the behaviors of dependent variables Y and they span the subspace onto which the independent variables X are projected. Cluster analysis is an unsupervised exploratory data analysis tool and was used to classify the samples into groups based on their similarities of specified characteristics (variables). It grew out work by biologists working on numerical taxonomy, and is a valuable visualization tool in data mining. Partial least squares (PLS) regression is a technique that reduces the predictors to a smaller set of uncorrelated components or factors and performs least squares regression on these components, instead of on the original data. PLS regression is especially useful when your predictors are highly collinear, or when you have more predictors than observations and ordinary least-squares regression either produces coefficients with high standard errors or fails completely. PLS does not assume that the predictors are fixed, unlike multiple regression. This means that the predictors can be measured with error, making PLS more robust to measurement uncertainty. PLS regression was primarily used to model the relationship between spectral measurements (NIR, IR, UV), which include many variables that are often correlated with each other, and chemical composition or other physio-chemical properties. In PLS regression, the emphasis was on developing predictive models. Therefore, it is not usually used to screen out variables that are not useful in explaining the response.

Keywords: Chemometric Technique, Spectroscopic Analysis, Predictive Models, Physicochemical Properties

Chemical transformations of 1,2,4-triazine derivatives

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1,2,4-Triazine is one of the best known heterocyclic systems and is still very popular among scientists designing new structures with biological activity. This popularity is due to its chemical properties— more electron-deficient system than pyridine, pyrimidine, pyrazine, or pyridazine—which have been used to construct a variety of mono and fused derivatives involved in diverse structure–activity relationship studies. A number of literature reports indicate the widespread use of this heterocyclic system, which is still a valuable substrate for many studies, including the design of new molecules with targeted biological activity. For this purpose, the triazine scaffold can be flanked with other polycyclic moieties or used as a ligand for a heterobimetallic complex. It is worth emphasizing that 1,2,4-Triazine is a structural element of the various formulations used in medicine and agriculture.[1] Growth of interest in the chemistry of 1,2,4-triazine has occurred due to the diverse biological activity of its derivatives which includes antibacterial, antiviral, anti-inflammatory, antiarrhythmics, antihypertensive, anticoccidiosis, antiepileptic, cytostatic, antifungal and herbicide effects. In recent decades, methods have been developed to synthesize derivatives of 1,2,4-triazine which rely on the direct introduction of the alkyl or aryl substituents or other functional groups. The substituted 1,2,4-triazines are prepared by the condensation reaction of the readily available 1,2-diketones with semicarbazide or thiosemicarbazide derivatives or by Suzuki and Stille reactions, as well as by the nucleophilic substitution of the appropriately substituted 1,2,4-triazines. The latter reaction has been widely used in our laboratory for direct synthesis of oximes of 5-acyl-1,2,4-triazines[12] which are useful substrates for the construction of 5-acyl-1,2,4-triazines, chiral 1,2,4-triazine alcohols, 2-acylpyridines, 3-acyl-5,6,7,8-tetrahydroisoquinolines and pyrazolo[4,3-*e*][1,2,4]triazines.

Keywords: Heterocyclic Systems, Pyridazine, Targeted Biological Activity

Antidiabetic Potential of Omani Medical Plants: A Case Study of Haplophyllum tuberculatum (Forssk.) A. Juss. by In Vitro and In Silico Approaches

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In a search for new drug-like molecules, we investigated Haplophyllum tuberculatum as a potential source of α-glucosidase inhibitors. Five new natural

products (**1-5**), and one previously synthesized compound (**6**), isolated here as a natural product for the first time, were isolated from an ethyl acetate extract. Additionally, fifteen known compounds (**7-21**) were also characterized. The structures of all compounds were elucidated by 1D- and 2D-NMR techniques and HR-ESI-MS. All phytochemicals were evaluated for inhibitory activity against α-glucosidase enzyme. Among them, six compounds exhibited notable inhbition with IC_{50} values of 2.28 ± 0.64 to 8.94 ± 0.37 μM, seven compounds had appreciable activity with IC_{50} values ranging from 12.14 ± 0.35 to 24.60 ± 0.57 μM, whilst six compounds exhibited weak activities with IC_{50} values of 36.52 ± 1.68 and 260.53 ± 3.18 μM, respectively, compared to the standard drug acarbose (IC_{50} = 875.75 ± 1.24 μM). The α-glucosidase inhibitory activities of all compounds are reported here for the first time. A kinetic study of the most potent compounds was also performed and exhibited concentration dependent type of inhibition. Furthermore, a structure- based prediction of the compounds' binding mode suggested that these inhibitors fitted exceptionally well within the active site of the target enzyme, α-glucosidase, forming multiple hydrogen and hydrophobic interactions with its active site residues. In conclusion, compounds with potent α-glucosidase inhibitory activity are abundant in nature and can be explored and further developed for treating diabetes mellitus.

Keywords: Haplophyllum Tuberculatum (Forssk.) A. Juss., Rutaceae, Alkaloids, A-Glucosidase Inhibition, NMR Spectroscopy, Molecular Docking

Metal–Organic Frameworks as Versatile Platforms for Modern Technologies

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Metal-organic frameworks (MOFs) are highly porous, crystalline materials composed of metal ions or clusters coordinated with organic ligands, offering tunable structures and exceptional surface areas. Their versatility has positioned them as transformative materials in diverse applications, including gas adsorption, drug delivery, and catalysis, in between many others. In gas adsorption, MOFs excel due to their high porosity and customizable pore chemistry. Their large surface areas, often exceeding 5000 m^2/g, enable efficient capture and storage of gases such as CO2, CH4, and H2. Functionalized MOFs, tailored with specific ligands, enhance selectivity and capacity, making them promising materials for carbon capture, natural gas storage, and hydrogen fuel technologies. Their structural stability and recyclability further bolster their practical utility. For drug delivery, MOFs offer a biocompatible platform with controlled release capabilities. Their tunable pore sizes and high loading capacities allow encapsulation of diverse therapeutic agents, from small-molecule drugs to biological macromolecules. Surface modifications enable targeted delivery and stimuli-responsive release, improving therapeutic efficacy while minimizing side effects. Biodegradable MOFs, such as those based on zinc or iron, are particularly

promising for biomedical applications, demonstrating low toxicity and compatibility with physiological environments. In catalysis, MOFs serve as highly efficient catalysts due to their well- defined active sites and porous structures, which facilitate reactant accessibility and product diffusion. Functionalized MOFs, incorporating metal nanoparticles or enzymes, enable applications in organic synthesis, pollutant degradation, and energy conversion processes like water splitting and CO2 reduction. Their ability to combine homogeneous and heterogeneous catalytic properties enhances reaction efficiency and selectivity. Overall, MOFs' structural versatility and multifunctionality make them pivotal in addressing global challenges in energy, health, and environmental sustainability, with ongoing research expanding their potential across these domains.

Keywords: MOFs, Catalysis, Drug Delivery, Gas Adsorption

Transition-Metal-Free C(sp²)-H Functionalization of Biologically Relevant Structures *via* Sustainable Methods

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The direct functionalization of C–H bonds is a crucial transformation in organic synthesis; however, reliance on precious transition-metal catalysts presents economic and environmental challenges. This talk will highlight our decade-long research program, which has developed sustainable, transition-metal-free strategies for the C(sp²)–H functionalization of biologically relevant scaffolds. By designing novel reagent systems as well as harnessing alternative energy inputs—including photochemistry, electrochemistry, and microwave/ultrasound irradiations—we have established efficient protocols for regioselective C–Halogen (X = Cl, Br, I), C–Chalcogen (S, Se, Te), and C–Nitrogen bond formation. Our interest in green chemistry principles, employing benign reagents, minimizing energy consumption, and reducing waste, is to provide practical and powerful alternatives for the late-stage diversification of complex molecules.

Keywords: C(sp²)-H Bond Functionalization, Green Chemistry, Transition-Metal-Free, Organic Synthesis, Bioactive Compounds

Design, Synthesis and Structural Studies of some New Azoles as Potential Biological Scaffolds

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Azole frameworks serve as privileged scaffolds in the contemporary drug design paradigm owing to their unique physicochemical profile that promotes the development of highly selective, physiological benevolent chemotherapeutics. Several azole nuclei function as bioisostere in medicinal chemistry and prompt the development of tailored therapeutics for targeting the desired biological entities. Besides, the azole scaffold forms an integral part of advanced drug

designing methodologies, such as target template in situ drug synthesis, which assists in the rapid identification of the hit molecules form a diverse pool of leads; and direct biomolecule-drug conjugation, along with bioorthogonal strategies that ensure localization, and superior target specificity of the directed therapeutic. Lastly, the structural diversity of the azole framework and high- yielding click synthetic methods provide a comprehensive Structure- Activity Relationship (SAR) analysis for design optimization of the potential drug molecules by fine-tuning the placement of different substituents critical for the activity. Azoles are nitrogen, sulfur, and oxygen-containing compounds with a five-membered ring system that comprises thiadiazole, oxadiazole, triazole, imidazole, isoxazole, pyrazole, and other rings. Mainly known as antifungal agents, azole derivatives demonstrate many other biological properties including anti-diabetic, anti-inflammatory, and anticancer activities. Azoles also show α-glucosidase inhibition, which includes derivatives of thiadiazoles, oxadiazoles, triazoles, diamine-bridged coumarinyl oxadiazole conjugates with phenylenediamine, benzidine and 4,4′- oxydianiline linkers, and 5,6-diaryl-1,2,4-triazine thiazoles. A new series of 1,3,4-oxadiazoles, 1,2,3-triazoles, pyrazoles and thiazoles have been synthesized and characterized by different spectroanalytical techniques. Fully characterized molecular structures were further studied by single-crystal X-ray diffraction where applicable. Density functional theory calculations at the B3LYP/6-31+G(d) level were performed to compare X-ray geometric parameters, molecular electrostatic potential (MEP), and frontier molecular orbital analyses of synthesized compounds. MEP analysis revealed that these compounds are nucleophilic. Moreover, the non-covalent interactions have been characterized using the NCI plot index. Frontier molecular orbitals (FMOs) analysis was performed for the evaluation of kinetic stability. All synthesized compounds were screened in vitro for different biological assays and diverse biological trends have been observed in different classes.

Keywords: Structure-Activity Relationship, potential drug molecules, bioisostere

The Potential of Metal-Based Compounds in Addressing Drug Resistance

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The rapid escalation of bacterial resistance and microbial evolution in recent decades demands the urgent need for more effective treatments and novel antiSmicrobials. In this work, heterocyclic Schiff base ligands were synthesized by reacting primary amine derivatives with various aromatic aldehydes and ketones in 1:1 and 1:2 molar ratios. The resulting imine based ligands were characterized using physical parameters (solubility, color, melting point), spectroscopic techniques (UV–Vis, FT–IR, 1H and 13C NMR, MS), and elemental analysis. Density functional theory (DFT) calculations were performed to validate experimental (UV Vis, FT–IR) results and investigate electronic properties (FMO, NBO, MEP, MAC), with global reactivity parameters derived

from FMO energy gaps indicating potential bioactivity. The ligands were subsequently employed to synthesize 3d- transition metal complexes in 1:1 and 1:2 molar ratios, which were characterized by physical data (color, solubility, decomposition points) and structural analyses (FT–IR, UV–Vis, MS, magnetic moments, molar conductance). Antibacterial and antifungal assays against selected strains revealed that most synthesized compounds, particularly the metal complexes, exhibited strong antimicrobial activity, in several cases when compared with standard drugs. These findings highlighted the potential of the synthesized ligands and their metal complexes as promising candidates for future biomedical applications.

Keywords: Schiff base Ligands, Bioactivity, Antibacterial Assay

Natural Products and Natural Products-Inspired in Cardiovascular Research

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One in every three deaths worldwide is caused by cardiovascular disease, estimating a total of 17.9 million deaths per year. By 2030, it is expected that more than 24 million people will die from cardiovascular disease (CVD) related complications. The most common cardiovascular health problems are deep vein thrombosis, pulmonary embolism, coronary heart disease, myocardial infarction, stroke, and high blood pressure. Inflammation has long been acknowledged as one of the leading causes of disease. A plethora of studies have shown inflammation causing both short-term and long- term damages to tissues in many organ systems, including the cardiovascular system. In parallel to inflammation processes, it has been discovered that apoptosis, a mode of programmed cell death, may also contribute to CVD development due to the loss of cardiomyocytes. Natural products and natural products-inspired compounds play an important role as nutritional supplements and provide potential health benefits in cardiovascular diseases (CVD). Compiling data from experimental, epidemiological and clinical studies indicates that dietary nutrients have profound cardioprotective effects in primary as well as secondary prevention of coronary heart disease, hence they are considered as cardiovascular friendly agents/compounds. In this presentation, the role of natural products and natural products inspired in CVS research at Universiti Kebangsaan Malaysia will be highlighted in different contexts and discussed, In addition, the therapeutic potential of cardiovascular friendly natural products and natural products-inspired compounds have been suggested.

Keywords: Cardiovascular Disease, Dietary Nutrients, Therapeutic Potential

COMPUTER SCIENCE

AI for Social Good in Healthcare: Supporting Doctors and Patients towards Disease Diagnostics

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Artificial Intelligence (AI) is reshaping healthcare by improving disease predictions, clinical decisions, and patient engagement. From classical expert systems to modern deep learning models, AI has advanced to process vast medical data, medical images, and records with exceptional accuracy. AI has proven to be a true companion for doctors and patients through modern tools, including cancer detection, radiology automation, and predictions for fatal diseases. This talk will explore the journey of AI in healthcare, discussing traditional approaches as well as current deep learning trends, while highlighting their social impact. A special insight will be provided on the rise of agentic AI systems that support clinicians and patients. The future aspects of AI in healthcare will also be discussed.

Keywords: Artificial Intelligence (AI), Healthcare Innovation, Deep Learning, Disease Prediction, Clinical Decision Support, Agentic AI Systems.

Fostering Innovation: From Final-Year Projects to Patents and Startups

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Innovation often begins in the classroom, with ideas that emerge from student curiosity, classroom projects, and final-year research. When nurtured with the right mentorship, resources, and vision, these ideas can grow into impactful solutions, leading to patents, startups, and real-world transformation. This keynote explores the journey of turning academic projects into meaningful innovations – highlighting success stories where student-led initiatives have secured competitive funding, developed intellectual property, and even laid the foundation for entrepreneurial ventures. Drawing from experiences in supervising funded projects, enabling students to file patents, and collaborating on industry-driven research, the session emphasizes practical strategies for fostering an innovation-driven culture in academic settings. The talk will inspire students to view their final-year projects as more than academic requirements, encourage faculty to act as innovation enablers, and demonstrate how universities can serve as launchpads for future entrepreneurs and change-makers.

Keywords: Innovation, Academic Projects, Entrepreneurship, Student Research, Patents, Industry Collaboration.

Unfolding the Metaverse: Opportunities and Challenges Ahead

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The concept of the Metaverse has rapidly shifted from a futuristic vision to a transformative technological paradigm that is reshaping the way individuals interact, work, and engage with digital environments. The Metaverse can be defined as a collective virtual space, created by the convergence of physical and digital realities, where immersive technologies such as augmented reality (AR), virtual reality (VR), blockchain, and artificial intelligence (AI) converge to deliver new forms of interaction. This emerging ecosystem is gaining momentum across diverse sectors including education, healthcare, business, entertainment, and social networking, offering unprecedented opportunities for innovation and growth. On the one hand, the Metaverse presents immense opportunities. It enables virtual collaboration, borderless communication, and immersive learning experiences, while creating new economic models such as digital assets, decentralized finance, and non-fungible tokens (NFTs). Businesses are exploring the potential of virtual marketplaces, organizations are adopting immersive workspaces for remote collaboration, and educational institutions are leveraging interactive 3D environments to enhance learning outcomes. Furthermore, the Metaverse fosters inclusivity by bridging geographical barriers and providing platforms for diverse communities to interact and engage in shared experiences.

Keyword: Metaverse, Virtual Reality (Vr), Augmented Reality (Ar), Blockchain, Artificial Intelligence (Ai), Digital Transformation, Immersive Technologies

Shaping the Future of Software Engineering Education in the Age of Generative AI

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Generative AI has already begun to transform the way we think, learn, and work. In higher education, particularly in software engineering, offers both opportunities and risks. For students, AI tools promise rapid feedback, automated code suggestions, and new ways to explore problem-solving. For teachers, they challenge us to rethink assessment, supervision, and the very skills we prepare our graduates to master. In this keynote, I reflect on my two decades of teaching experience, spanning software engineering, databases, programming, and computing foundations, as well as my ongoing supervision of master's theses in Sweden and Pakistan. I will discuss how I have integrated student-centered learning strategies such as peer-led assessment, reflective journaling, and project-based assignments, and ask how such approaches can be re-imagined in the age of AI. I will explore three central questions: How do we ensure students develop deep, critical skills when AI can generate solutions instantly? How can AI become a partner in feedback and learning rather than a shortcut to answers? And how can teachers safeguard academic integrity while fostering creativity and innovation?

The keynote will conclude with practical directions for educators and researchers: designing new forms of assessments, integrating GenAI tools responsibly into coursework, and preparing the next generation of software engineers not just to use AI but to question it, refine it, and lead its ethical application in industry and society.

Keywords: Generative AI, higher education, software engineering, student-centered learning, academic integrity, ethical AI integration.

Integrating Agile Practices in Global Software Development for Secure Software Engineering: Addressing Current Challenges and Future Directions

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Global Software Development (GSD) has become a norm in distributed, cross-cultural, and time-zoned teams, and while Agile methodologies have proven effective in enhancing collaboration and adaptability, their integration with secure software development remains challenging. Security concerns often conflict with the fast- paced, iterative nature of Agile, and these issues are further amplified in GSD contexts due to geographical distribution, cultural barriers, and communication overhead. Despite the maturity of Agile practices, secure software development still faces persistent challenges such as delayed security integration, lack of standardized practices across distributed teams, limited awareness of security requirements, and fragmented accountability, with current approaches either compromising agility for security or neglecting critical security aspects, thus creating gaps in quality and compliance. This work aims to explore how Agile practices can be systematically tailored to support secure software development in distributed global environments by embedding "security by design" into Agile workflows while maintaining alignment, collaboration, and efficiency among teams. The discussion synthesizes insights from literature, industry practices, and case studies, with a focus on adapting Agile ceremonies to integrate security (e.g., backlog grooming, sprint reviews), incorporating DevSecOps pipelines in GSD for continuous security validation, and addressing cultural and communication challenges through structured collaboration models. The expected contributions include a conceptual framework aligning Agile practices with secure software development in GSD, strategies for balancing agility, security, and distributed collaboration, and practical guidelines for practitioners and researchers to mitigate the tension between rapid delivery and robust security. Ultimately, by rethinking the role of Agile in GSD through the lens of security, this work highlights pathways to overcome current challenges and sets directions for building resilient, adaptive, and secure global software systems.

Keywords: Agile software development; global software development (gsd); secure software engineering; security by design; distributed collaboration; software security challenges.

A User-Centric Requirements Elicitation Framework for Global Software Development Based on Personality Traits

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The requirements elicitation is considered as the foremost important phase of the requirements engineering during the software development lifecycle with goal of gathering requirements of anticipated product. Usually, the requirements elicitation process is full of cross-sectional conversations and frequent interactions among key stakeholders of the product for conceptualization of intended product. The social and collaborative nature of requirements elicitation process baselines its primary dependence on human-factors like behavior, styles/patterns, preferences and personality traits of its participants during traditional in-house software development as-well-as modern global software development. Accordingly, user personality traits have a great influence on overall process of requirements elicitation for global software development teams working on offshore projects due to inherited social and cultural diversity of involved participants. Hence, there was a serious need to devise a user-centric requirements elicitation framework, which should incorporate user personality traits along with other concerned factors of RE and GSD for global software development teams working on offshore projects. This frameworkwill serve as an asset for project managers and company heads to better plane the configuration of requirements elicitation teams and elicitation context by looking at the personality traits of product users.

Keywords: Requirements elicitation, requirements engineering, global software development (GSD), personality traits, user-centric framework, human factors

INFORMATION TECHNOLOGY

Unraveling the Tangle of Disinformation: A Multimodal Approach for Fake News Identification on Social Media

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The rapid proliferation of disinformation on social media platforms poses significant challenges to public trust, societal stability, and informed decision-making. Traditional fake news detection approaches often rely on textual content alone, which limits their effectiveness against increasingly sophisticated and multimodal disinformation campaigns. In this paper, we propose a multimodal framework that integrates textual, visual, and contextual features to enhance the accuracy and robustness of fake news identification. Our approach leverages advanced natural language processing (NLP) models for semantic analysis, computer vision techniques for image verification, and graph-based methods for capturing user interaction patterns. By fusing these heterogeneous modalities, the

system provides a comprehensive assessment of news veracity in real time. Experimental results on benchmark social media datasets demonstrate that the proposed multimodal model significantly outperforms unimodal baselines, achieving improved precision, recall, and F1- scores. This research contributes to building more resilient systems for combating disinformation, with potential applications in fact-checking, digital journalism, and online content moderation.

Keywords: Natural Language Processing (NLP), Multimodal Disinformation, Semantic Analysis, Computer Vision

Deep Learning-Based Classification Systems: Methods, Applications, and Challenges

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Deep learning has emerged as a transformative paradigm in the development of classification systems across diverse domains, owing to its remarkable ability to automatically learn hierarchical feature representations from raw data. This paper provides a comprehensive overview of deep learning-based classification methods, highlighting popular architectures such as convolutional neural networks (CNNs), recurrent neural networks (RNNs), transformers, and hybrid models. We examine their effectiveness in a wide range of applications including computer vision, natural language processing, healthcare diagnostics, cybersecurity, and smart city infrastructures. Despite their success, deep learning-based classifiers face significant challenges related to interpretability, computational cost, data dependency, and vulnerability to adversarial attacks. We further discuss current advancements in model optimization, transfer learning, and explainable AI aimed at overcoming these limitations. Finally, open research directions and future opportunities are identified to guide the development of more efficient, robust, and trustworthy classification systems.

Keywords: Convolutional Neural Networks, Recurrent Neural Networks, Hybrid Models, Natural Language Processing

The Role of Artificial Intelligence in Modern Cybersecurity

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The rapid evolution of cyber threats in today's interconnected world demands innovative and adaptive defense mechanisms. Artificial Intelligence (AI) has emerged as a key enabler in modern cybersecurity, offering capabilities that extend beyond traditional rule-based systems. This paper explores the transformative role of AI in strengthening cybersecurity through threat detection, anomaly identification, intrusion prevention, and automated response systems. We review the application of machine learning, deep learning, and natural language processing in analyzing vast amounts of network data to detect sophisticated attacks in real time. Special emphasis is placed on AI-driven

security solutions, such as predictive analytics, behavior-based detection, and intelligent threat hunting. Despite its promise, the integration of AI into cybersecurity poses challenges, including model interpretability, data privacy, adversarial attacks, and ethical concerns. The paper concludes with an outlook on how hybrid human-AI collaboration and advances in explainable AI can shape the future of resilient and trustworthy cybersecurity systems.

Keywords: Cyber Threats, Artificial Intelligence, Threat Detection, Anomaly Identification, Intrusion Prevention

Student Performance Prediction using Multi-Layers Artificial Neural Networks

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Accurately predicting student performance has become a crucial task in higher education, as it enables early identification of at- risk learners and supports data-driven academic interventions. This study proposes a predictive framework based on Multi-Layer Artificial Neural Networks (ANNs) to model the complex relationships between student attributes and academic outcomes. Input features such as demographic information, academic history, attendance, learning behavior, and socio-economic background are used to train the model. The proposed ANN architecture leverages multiple hidden layers to capture non-linear dependencies and improve prediction accuracy compared to conventional machine learning methods. Experimental results demonstrate the effectiveness of the model in predicting student grades and classifying performance levels. This research highlights the potential of deep learning approaches in enhancing student support systems, personalized learning strategies, and academic advising**,** ultimately contributing to improved educational quality and institutional decision-making.

Keywords: Multi-Layer Artificial Neural Networks, Demographic Information, Conventional Machine Learning, Personalized Learning Strategies

Blockchain-based initiatives: current state and challenges

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Blockchain technology has emerged as a transformative force across diverse sectors, offering decentralized, transparent, and secure solutions for data management, financial transactions, and governance. In recent years, blockchain-based initiatives have expanded beyond cryptocurrencies into domains such as supply chain management, healthcare, education, e-governance, and smart contracts. Despite its potential, the widespread adoption of blockchain faces significant challenges including scalability, energy consumption, interoperability, regulatory uncertainty, and security concerns. This paper provides a comprehensive overview of the current state of blockchain initiatives,

highlighting real-world applications, adoption trends, and the technological advancements driving their growth. Furthermore, the study discusses critical challenges that hinder large- scale deployment and suggests potential pathways for overcoming these barriers. By analyzing both opportunities and limitations, this work contributes to a deeper understanding of blockchain's evolving role in reshaping industries and guiding future innovation.

Keywords: Blockchain Technology, Smart Contracts, Chain Management, Energy Consumption

Edge AI: Machine Learning on IoT and Mobile Devices

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The rapid growth of the Internet of Things (IoT) and mobile devices has generated massive volumes of data that require real-time processing for intelligent decision-making. Traditional cloud-based machine learning models face challenges such as high latency, bandwidth limitations, and privacy concerns. Edge Artificial Intelligence (Edge AI) has emerged as a promising paradigm that enables machine learning algorithms to run directly on IoT devices, smartphones, and edge servers, thereby reducing dependency on centralized cloud infrastructure. This paper explores the current state of Edge AI, highlighting advancements in lightweight deep learning models, hardware accelerators, and on-device training techniques. Real-world applications in smart cities, healthcare, autonomous vehicles, and industrial automation are discussed to demonstrate its transformative potential. Furthermore, the paper examines key challenges including limited computational resources, energy efficiency, model optimization, and security. By providing insights into both opportunities and barriers, this study emphasizes the critical role of Edge AI in shaping the next generation of intelligent and connected systems.

Keywords: Edge Artificial Intelligence, Internet of Things, Machine Learning, Lightweight Deep Learning Models

Detection of Deepfakes using AI & Machine Learning

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The rapid advancement of artificial intelligence hasenabled the creation of hyper-realistic synthetic media, commonly known as deepfakes. While this technology has potential applications in entertainment, education, and creative industries, it also poses serious threats to privacy, security, and the integrity of digital information. Deepfakes can be weaponized for disinformation campaigns, identity theft, and cybercrimes, making their detection a pressing research challenge. This paper explores AI and machine learning-based approaches for detecting deepfakes in images, audio, and video content. Specifically, it highlights the use of convolutional neural networks (CNNs), recurrent neural networks (RNNs), transformer- based architectures, and multimodal learning techniques to

identify subtle inconsistencies in visual frames, facial expressions, and audio-visual synchronization. Furthermore, the study discusses benchmark datasets, evaluation metrics, and real-world applications of detection systems. Finally, challenges such as dataset limitations, adversarial attacks, and the evolving sophistication of generative models are addressed, alongside recommendations for developing robust, ethical, and scalable deepfake detection solutions.

Keywords: Convolutional Neural Networks, Recurrent Neural Networks, Deepfakes, Hyper-Realistic Synthetic Media

MATHEMATICS

The Integrator Engine: How 21st Century Mathematics Powers Sustainable Development through Convergence Science and Planetary-Scale Computation

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Mathematics has undergone a fundamental transformation in the 21st century, evolving from a collection of specialized disciplines to humanity's most powerful integrator engine for addressing planetary-scale challenges embodied in the Sustainable Development Goals (SDG). This keynote explores how modern mathematical convergence, spanning quantum field theory to global systems modelling, provides the computational and theoretical foundation essential for sustainable planetary stewardship in the Anthropocene with artificial intelligence (AI) serving as a critical accelerant. The presentation begins by examining recent breakthroughs in computational mathematics that have revolutionized our approach to complex systems. We highlight how machine learning-enhanced numerical methods now optimize renewable energy grids across multiple scales (Chen et al., 2023, Nature Energy), how quantum- inspired algorithms solve previously intractable optimization problems in resource allocation (Kumar & Zhang, 2024, Science Advances), and how topological data analysis reveals hidden patterns in climate and health datasets (Rodriguez-Martinez et al., 2022, PNAS). Central to this discussion is the concept of "mathematical convergence science" the unprecedented integration of pure theoretical advances with computational power to address real-world challenges. We demonstrate how recent developments in stochastic partial differential equations are transforming epidemic modeling for global health policy (Thompson & Li, 2023, Nature Medicine), how advances in computational fluid dynamics are enabling next-generation climate simulations for urban resilience planning (Patel et al., 2024, Journal of Computational Physics), and how mathematical ecology informed by category theory is revolutionizing biodiversity conservation strategies (Williams et al., 2022, Ecology Letters) as shown in Figure 2. The keynote showcases emerging mathematical frontiers essential for the SDGs: geometric deep learning architectures that capture multi-scale climate dynamics (Anderson & Park, 2023, Nature Climate Change), quantum computing applications in sustainable

chemistry (Johnson et al., 2024, Chemical Reviews), network science approaches to understanding social-ecological systems (Garcia & Smith, 2022, Science), and uncertainty quantification methods for long-term sustainability planning under deep uncertainty (Brown et al., 2023, Global Environmental Change).We examine how mathematical education must evolve to prepare researchers for convergence science, emphasizing computational fluency, interdisciplinary communication, and ethical awareness in algorithm design. Recent studies show that interdisciplinary mathematical training significantly improves problem-solving capabilities for sustainability challenges (Lee et al., 2024, Educational Studies in Mathematics). The presentation concludes with a vision of mathematics as the essential integrator engine of the 21st century, not merely solving individual problems but revealing the deep interconnections between SDGs and enabling holistic approaches to planetary stewardship. We argue that the most transformative mathematical discoveries will emerge at the intersection of theoretical depth and computational power, driven by the urgent need for sustainable solutions. With AI acting as an enabling force, SDG alignment reinforces mathematics as the primary integrator. This restructured abstract maintains the original's scientific rigor while strengthening AI relevance, and clarifying the hierarchy of mathematical innovation driving sustainable development.

Keywords: Mathematical Convergence, Epidemic Modelling

Generating Approximate Closed-Form Solutions of Partial Differential Equations

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It is often possible to transform a partial differential equation (PDE) into an ordinary differential equation (ODE) through an appropriate change of variables. However, the resulting ODE is not always solvable in terms of elementary functions. In such cases, numerical methods are typically employed to solve the reduced ODE. As yet, there are no established systematic procedures for using these numerical solutions to reconstruct the solution of the original PDE. This work demonstrates a systematic approach to address such situations.

Keywords: PDE, ODE

Exploring Operads: Structure, Symmetries, and Species

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Operads provide a unifying language for describing compositional and hierarchical structures across a broad spectrum of mathematical contexts. This talk

offers a concise historical overview of operads and introduces their formal definition, emphasizing their structural composition rules and inherent symmetries governed by permutation actions. We begin by demonstrating that the species of cycles naturally forms an operad. Extending beyond earlier studies, which focus solelyon the operadic structure in the first entry, we present new results showing that the species of posets also forms an operad in the second entry. Letting L denote the category of linear orders, we prove that for any poset Q, the undercategory Q/L admits an operadic structure. The central theorem introduces the operadic composition on the category of finite posets P, defined via the lexicographic sum. It is shown that for every poset Q, the undercategory Q/P likewise supports an operad structure. This exposition combines foundational theory with recent advances, offering insights into the flexibility of operads and their role in organizing combinatorial data via species.

Keywords: Operads, posets

Existence and stabilization of impulsive second-order integro-differential equations with multiple kernels and delays

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The mathematical formulation of many dynamic systems naturally leads to second-order impulsive delay integro-differential equations. This work establishes new existence and stabilization results for such equations with multiple time delays. The existence of solutions is obtained via Schaefer's fixed-point theorem, while stabilization is proved using Lyapunov–Krasovskiĭ functionals. These results improve and extend several well-known contributions in the literature. An illustrative example is provided to demonstrate the applicability of the theoretical findings.

Keywords: Dynamic systems, integro differential equations

Fractional Calculus and its Applications

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In this talk, I will speak about some fundamental concepts of fractional calculus with examples and applications in heat transfer and fluid dynamics for different geometrical surfaces. Furthermore, I will discuss two different approaches of fractional modelling with artificial replacement and generalized constitutive laws respectively. At last, I will draw the conclusion that which approach depicts accurate memory of the problem.

Keywords: Fractional calculus

STATISTICS

Sensor-Enabled Machine Learning and Statistical Modeling for Foot-and-Mouth Disease Surveillance in Botswana

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Foot-and-Mouth Disease (FMD) poses a persistent threat to Botswana's livestock sector. This keynote presents a sensor-enabled, machine learning (ML) and statistical modeling framework for enhanced FMD surveillance and control. Sensor networks capture real- time data on livestock movement, environmental factors, and health indicators, which are analyzed using ML algorithms and geo statistical methods to detect hotspots, forecast outbreaks, and guide targeted interventions. The approach improves early detection accuracy, optimizes vaccination and movement control strategies, and supports proactive, data-driven decision-making for sustainable livestock management and national biosecurity.

Keywords: Machine Learning, Statistical Modeling, sensor networks, FMD, accuracy

Intelligent Data Journeys: Statistical Innovations in Image Analytics

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In an era where images have become the dominant form of information, the ability to extract, model, and interpret patterns within pixel-level data is transforming science, industry, and policy. This keynote will explore the convergence of statistical methodologies and machine learning techniques in unlocking the hidden narratives within image datasets. Drawing on applications from environmental monitoring, biomedical imaging, and remote sensing, I will demonstrate how innovative statistical frameworks—from dimension reduction to deep learning—are redefining accuracy, scalability, and interpretability in image analytics. Special emphasis will be placed on bridging classical statistical thinking with modern AI approaches to ensure robust, reproducible, and domain-relevant outcomes. The session will also highlight challenges such as high-dimensional noise, data sparsity, and the balance between automation and expert knowledge. By tracing the journey from raw pixels to actionable insights, this talk aims to inspire researchers and practitioners to adopt intelligent, cross-disciplinary strategies for tackling the next generation of data challenges.

Keywords: Intelligent Data, Statistical methodologies, machine learning techniques, imaging, AI approaches

Data Wrangling: The Foundation of Data-Driven Decision Making

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Data empowers informed decision-making by providing actionable insights from vast and diverse information streams. It is the backbone of the today's digital

world. Its effective use fuels economic growth, scientific advancements, and personalized solutions in an in an interconnected, technology driven landscape. Data wrangling is a comprehensive process involving several key steps (from data discovery to publication) to transform raw, diverse, messy, and chaotic datasets into a format ready for analysis. This process also closes the knowledge gap between intricate data and useful development insights which is the core of the data-driven decision making. The relevance of data wrangling continues to grow for several reasons including volume & variety of data, advanced analytics & AI, and compliance & data governance etc.

Keywords: Analytics, decision-making, data quality, Data Wrangling, data discovery.

ZOOLOGY

Global Problems and Challenges of Aquatic Organisms and Foods

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Aquatic food systems nourish 3.3 billion people globally and provide livelihoods to 600 million, almost half of them women. 90% of small-scale fishers live in low- and middle-income countries. Aquatic food systems are central to a global transition toward sustainable, equitable, and healthy food systems. While essential for nutrition and livelihoods, these systems face complex challenges. Climate change and environmental degradation affect production while changing consumption patterns and increasing demand exacerbate inequalities. Topics to be discussed in this work will include the role of aquatic foods in global food security and nutrition, their potential as a solution to climate change, and the contribution of effective management to long- term biodiversity goals. Solutions and actions to address urgent challenges facing aquatic food systems, such as climate change and plastic pollution, will also be examined. As a result, Fisheries and Aquaculture programmes will continue to provide the most up-to-date and evidence-based information on the sector's current and emerging challenges, growth and innovations, and policy, scientific and technical insights, enabling policy makers, managers, scientists, fishermen, farmers, traders, civil society and a wide and growing audience to benefit from the evidence-based information.

Keywords: Aquatic food systems, Climate change, Global food security and Challenges

Temporal Decline in Consanguineous Marriages in Pakistan: Trends and Prospects

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Pakistan bears a substantial burden of hereditary and congenital anomalies, with their incidence nearly doubling in the context of parental consanguinity. Consanguineous unions (CUs) are deeply embedded in the socio-cultural fabric of Pakistani society, where longstanding traditions continue to favor such marital practices. This study aims to investigate the determinants and temporal shifts in CU patterns across Pakistan. In this cross-sectional study, data were collected from 5,000 ever-married individuals residing in five major metropolitan cities of Pakistan. Information on marital types, bio- demographic variables, and paternal consanguinity was gathered and analyzed using descriptive statistics and multivariable logistic regression models. The overall prevalence of CUs was found to be 50%, with the inbreeding coefficient (F) estimated at 0.027. Multiple bio-demographic variables emerged as significant predictors of consanguinity. Notably, the prevalence of CUs showed a marked decline among younger age groups, reflecting a generational shift away from traditional consanguineous practices. The analysis further revealed positive trends: rising literacy rates, increased average age at marriage, and a reduction in exchange marriages over time. These socio-demographic improvements appear to correlate with the observed decline in CU rates. This study, based on a robust and sizeable primary dataset, provides compelling evidence of a gradual but significant decline in consanguineous marriages in northwestern Pakistan. With continued social progress, it is projected that the prevalence of inherited and congenital disorders will also decline, driven in part by the decreasing inbreeding coefficient in the population.

Keywords: congenital anomalies, consanguineous unions, inbreeding coefficient

Genetic Diagnosis in the Era of Precision Medicine and Beyond

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Advances in genomic technologies have transformed the diagnosis and management of genetic disorders, moving healthcare from a “one-size-fits-all” model to precision medicine tailored to the individual’s genetic makeup. In Pakistan, with its high rates of consanguinity, large family structures, and unique genetic architecture, the potential impact of genomic diagnosis is profound. This talk will explore how next-generation sequencing and bioinformatic tools are reshaping clinical practice, enabling earlier and more accurate detection of genetic conditions, including rare epilepsies and metabolic disorders. We will discuss the opportunities and challenges in integrating genomic medicine into Pakistan’s healthcare system— ranging from infrastructure and training gaps to ethical, cultural, and cost considerations, through some examples from our research work. Looking beyond diagnosis, we will consider how genetic insights can inform targeted therapies, preventative strategies, and public health policies, paving the

way for a sustainable, equitable precision medicine framework in low- and middle-income countries.

Keywords: Genetic Testing, Pakistan, Affordable, Risk, Population

Updated Records of Orthoptera Diversity and Conservation Concerns in Pakistan"

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The last country-level update on short-horned grasshoppers (Orthoptera: Acrididae) of Pakistan was published in 2024 by Sultana & Song. Since then, the first author has conducted periodic field collections and photographic documentation, resulting in numerous new country-level records. Based on these collections and previously existing data, a total of 2,665 specimens were examined over the past decade from diverse climatic zones, including Sindh, Balochistan, Punjab, Khyber Pakhtunkhwa, Gilgit-Baltistan, and Azad Jammu & Kashmir. The material was taxonomically sorted into major families, with Acrididae dominating (1,379; 51.74%), followed by Pyrgomorphidae (257; 9.64%), Tettigoniidae (146; 5.48%), Tetrigidae (122; 4.58%), Gryllidae (71; 2.66%), Tridactylidae (70; 2.63%), Schizodactylidae (37; 1.39%), and Trigonidiidae (34; 1.28%). Additionally, 167 specimens (6.27%) were identified only to the order level, 55 specimens (2.06%) belonged to seven other families, and364 specimens (13.66%) remained unidentified at the family level. In parallel, online biodiversity platforms such as the Orthoptera Species File Online, BugGuide, and iNaturalist have emerged as valuable and generally reliable supplementary sources of distributional data. Building on these resources, a comprehensive account of Orthoptera diversity across Pakistan is presented here. Among Acrididae, the subfamily Oedipodinae was reported in considerable numbers from various and previously unrecorded habitats. Many species of this subfamily exhibit cryptic coloration, closely matching local soils, sands, or rocky substrates, and are typically associated with sparsely vegetated areas. Certain taxa show strong substrate specificity, occurring only on rocks, sand, or gravel, while others are most abundant in areas where lichens cover the ground surface. In addition, unexpected distributions of Tridactylidae, Schizodactylidae, and Trigonidiidae were also recorded from new localities. This study significantly expands the available distributional data and provides several new country-level records, thereby updating and enriching the national inventory of Orthoptera.

Keywords: Orthoptera: Acrididae, BugGuide, Pyrgomorphidae

Nanopore Sequencing for Rapid Surveillance of Tick-Borne and Other Vector-Borne Diseases in Pakistan

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Vector-borne diseases (VBDs) remain a significant public health and economic challenge in Pakistan, affecting both human and animal populations. Tick-borne pathogens, including Anaplasma, Babesia, and Theileria species, pose threats to livestock health, food security, and zoonotic safety. Rapid, accurate, and field-deployable surveillance is essential for early detection and control. The present study demonstrates the application of Nanopore sequencing as a core tool in an integrated surveillance framework for VBDs, with emphasis on tick-borne infections. Field sampling was conducted in farmed and wildlife animals, followed by portable Nanopore sequencing for real- time pathogen identification. Results show that Nanopore sequencing offers rapid turnaround, high portability, and adaptability in resource- limited settings, making it suitable for on-site diagnostics and outbreak investigations. Despite challenges such as higher raw read error rates and the need for bioinformatics expertise, advancements in sequencing chemistry, base calling algorithms, and analysis workflows are improving accuracy and usability. This approach strengthens One Health surveillance networks, supports timely interventions, and reduces diagnostic delays for both veterinary and public health sectors. Integrating Nanopore sequencing with community-based vector monitoring and GIS tracking can significantly enhance Pakistan's preparedness against tick-borne and other vector-borne diseases, contributing to improved animal health, food security, and zoonotic risk mitigation.

Keywords: Nanopore sequencing, Tick-borne pathogens, Vector- borne diseases, One Health surveillance

Beyond Folic Acid: The Importance of a genetic contribution in the Etiology of Meningomyelocele

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In Pakistan, meningomyelocele is a prevalent and disabling congenital anomaly. Our international collaboration, the Spina Bifida Sequencing Consortium, has focused on identifying the genetic factors contributing to this condition. Through exome and genome sequencing of a large set of parent-offspring trios, we identified a significant genetic link: the common 22q11.2 chromosomal deletions. Our analysis suggests this deletion increases the risk of meningomyelocele by an estimated 23-fold. A separate analysis of a cohort with this specific deletion further confirmed a 12- to 15-fold increased risk of neural tube defects. We pinpointed one of the key genes within the deleted region, Crkl, and found that its absence alone was enough to cause neural tube defects in animal models. Critically, It observed that this genetic risk was exacerbated by maternal folate deficiency, and could be partially mitigated by folate supplementation. This research provides crucial genetic insight for clinicians and genetic counselors in world including Pakistan, establishing the 22q11.2 deletion as a major contributor to meningomyelocele and reinforcing the vital role of folic acid in both prevention and risk management.

Keyword: meningomyelocele, spina Bifida, Crkl, neural tube defects

ABSTRACTS
ORAL
PRESENTATIONS

BOTANY

BOT-1619: Unraveling the Potential of Bioinspired Zn-Fe_2O_3 nanocomposite on *Sorghum bicolor*

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As the fifth most significant grain crop in the world, Sorghum bicolor grows on over 40.9 million hectares of land worldwide and produces an average of almost 58.7 million tons each year. Green-synthesized nanoparticles (NPs) have gained great attention in agriculture due to their environmental friendliness and affordability while serving as potential biofertilizers. The present study is conducted to assess the uptake and translocation of green synthesize Zn-Fe2O3 nanocomposite (NCs) and to evaluate its effect on the yield of sorghum, using neem (Azadirachta indica) leaf extract. The synthesized nanocomposite is confirmed by, Fourier transfer infrared spectroscopy analysis (FTIR), X-ray diffraction analysis (XRD), Ultraviolet **(**UV**)** Visible Spectroscopy, and scanning electron microscopy analysis (SEM). Sorghum bicolor is grown in different concentrations of Zn-Fe2O3 nanocomposite (25, 50, 75, 100ppm). The thin cross sections of plant parts are examined by microscope to confirm the presence of nanocomposites. Nanocomposite uptake and accumulation are more in plants treated with high concentrations (75 and 100ppm). NCs improve plant height, fresh weight, dry weight, total chlorophyll content, nitrogen content and nutrient absorption. In the future, this study's findings could be very helpful in determining the potential deliverance and retention of plant-based nanoparticles in the fields of agriculture and medical sciences.

Keywords: Zn-Fe2O3 nanocomposite, Characterization, NCs uptake, Improved plant height

BOT-1592: Phytochemical Profiling and Pharmacological Effect of Monotheca buxifolia: Validating Its Biological Potential

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Medicinal plants, with their rich repertoire of bioactive secondary metabolites, serve as vital sources of natural products with therapeutic potential. *Monotheca buxifolia* (Falc.) A. DC., traditionally used against kidney, liver, and digestive disorders. However, a comprehensive scirntific validation ot its phytochemical composition and multifaceted phramcological properties remain linited. This study aims to bridge this gap by systematically investigating *M. buxifolia* leaves and stems extracts and fractions.The crude methanol extracts were subjected to vioactivity-guided fractionation using column chromatography. The compounds were characterized by nuclear magnetic resonance (NMR), and high-resolution

mass spectrometry (HR-MS). A comprehensive phytochemical and pharmacological evalution was undertaken, cncompassing the quantification of total phenolic and flavonoid contents. Antioxidant capacity was assessed by various assays: total antiocidant capacity (TAC), total reducing power (TRP), and radical scavenginh (DPPH, and ABTS). The therapeutic potential was further evaluated through enzyme inhibition assays targeting key metabolic enzymes (α-amylase, urease, and lipase). Antimicrobial efficacy was tested against a panel of bacterial and fungal strains, and toxicity was evaluated using a brine shrimp letality assay. Phytochemical analysis led to the identification of three principle compounds such as uercetin (MM-1), 2-hydroxybenzoic acid (Salicylic acid; MM-2), quercetin-3-O-rutinoside (Rutin; MM-6). These showed significant dose-dependent antioxidant activities, with quercetin exhibiting the most potent effects, nothably in reducing power (86.9 µg AAE/mg) and metal chelation (83.8%). The extracts and fractions showed remarkable enzyme inhibition, particularly against urease (69.8–80.6%) and lipase (64.0–78.9%) suggesting potential for managinf digestive and metabolic diorders. Antimicrobial assays revealed broad-spectrum activity with pronounced inhibition zones against *Fusarium solani* (18 mm) and *Staphylococcus aureus* (15 mm). The study provide a robust scientific foundation for ethnopharmacological importance of *M. buxifolia*. The isolated flavonoids and phenolics compounds are established as potent antioxidant, antimicrobial, and enzyme inhibitory agents. These findings underscore the potential of *M. buxifolia* as a promising source for developing natural product-based the natural product-based therapeutics for infections, metabolic, and oxidative stress-related diseases.

Keywords: Monothea buxifolia, antioxidant activity, enzyme inhibition, antimicrobial activity, natural products.

BOT-1638: Green Nano-Priming: *Tribulus terrestris* - Synthesized Nanoparticles Improve Salt Tolerance in Wheat

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The productivity of wheat, a vital crop in South Asia, is severely threatened by soil salinity. This study evaluated the potential of green-synthesized nanoparticles (NPs) to ameliorate salt stress during seed germination. Zinc oxide (ZnO), magnesium oxide (MgO), and magnesium-doped ZnO (Mg-ZnO) NPs, fabricated using a *Tribulus terrestris* L. extract, were applied at 5 mg/L and 25 mg/L concentrations under saline conditions (0–0.2 M NaCl). Physiological assessments revealed that Mg-ZnO NPs at 5 mg/L were optimal for overall seedling vigor across all stress levels. Under severe salinity (0.15–0.2 M), the lower concentration (5 mg/L) of all NPs was more effective, while higher concentrations (25 mg/L) benefited germination under mild stress. The results confirm the efficacy of green-synthesized NPs, particularly Mg-doped ZnO, as a promising nano-priming strategy for enhancing salinity tolerance in wheat. Future work should focus on large-scale application methods and environmental safety assessments.

Keywords: Salinity, Green chemistry, seed germination, Tolerance, Optimal conditions

BOT-1928: Biogenic synthesis of Zinc Oxide Nanoparticles using *Thymus linearis* Extract, Characterization and Evaluation of Different Biological Activities

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Zinc oxide nanoparticles possess unique and fascinating properties and have gained the significant attention of scientific community due to their multifaceted applications in different commercial areas. However, the traditional methods for the preparation of ZnO-NPs are linked with environmental and health hazards. To overcome these problems and challenges, the scientists have developed an alternate route for the synthesis of multifunctional nanoparticles known as green synthesis, which uses different natural resources and bio-templates. In the present research study, ZnONPs have been prepared using *Thymus linearis* (TL) aqueous extract as both reducing and stabilizing agents. Several analytical methods were employed to validate the synthesis of as-prepared ZnONPs. FTIR, SEM, EDX. XRD analysis was done to understand the crystalline nature of biogenic ZnONPs and the size was calculated about 30.39 nm. Furthermore, the TL-ZnONPs were examined for multifaceted biological activities. The antibacterial properties were demonstrated using different bacterial strains revealing significant antibacterial potential. The maximum resistance was observed in case of *Enterococcus faecalis* (MIC 125µg/ml), however *Staphylococcus saprophyticus* (MIC 31.25µg/ml) was found to be the most sensitive among all strains. The fungicidal properties were demonstrated using different fungal strains. The maximum resistance against all doses was observed in case of *Aspergillus flavus* (MIC 125 µg/ml). However, *Aspergillus niger* (MIC 31.25µg/ml) was found to be the most sensitive among all strains. Further, our *T. linearis*-ZnO nanoparticles revealed excellent cytotoxic potential against nascent brine shrimps larva's (IC_{50} 34.16 µg/ml). In summary, our NPs have shown strong biological potential against different assays. In future we recommend further biological activities using *in vitro* and *in vivo* models.

Keywords: Thymus linearis, Zinc Oxide nanoparticles, Antibacterial, Antifungal, Cytotoxic potential.

BOT-1971: Dhamasa Under the Lens: Correcting the Botanical Identity of *Fagonia* Species in Pakistan

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For decades, the name *Fagonia cretica* has echoed through Pakistan's botanical literature and herbal traditions, often cited as a native species and linked to the widely used medicinal plant "Dhamasa." Yet this attribution, though well-intentioned, is scientifically inaccurate. Global databases such as *Plants of the World Online* (POWO, 2025) and recent molecular studies (Khan et al., 2023) clearly establish *Fagonia cretica* L. as a distinct Mediterranean species, native to regions like Crete, Greece, and North Africa—with no verified presence in Pakistan. The confusion traces back to historical synonymy in the *Flora of Pakistan* (Ghafoor, 1974), where *F. cretica* was misapplied to *Fagonia indica* var. *indica*, a mistake formally flagged in taxonomic literature as *Fagonia cretica* auct. non Linn., meaning "*F. cretica* as used by authors, but not as described by Linnaeus." Herbarium specimens, field records, and species mapping now reinforce this correction: locally collected samples consistently identify *Fagonia indica* and its varieties (e.g., *var. schweinfurthii*, *var. aucheri*, *var. subinermis*) in areas such as Karachi, Tharparkar, and Zhob; *Fagonia bruguieri* and its varieties in Makran and Lasbela; and other species like *F. olivieri*, *F. glutinosa*, and *F. ovalifolia subsp. pakistanica*—but never *F. cretica*. It is also notable that the genus *Fagonia* has recently been subsumed under *Zygophyllum* in updated classifications (APG IV, 2016; POWO, 2025), meaning all names mentioned here are formally *Zygophyllum* species. This clarification is not just a taxonomic footnote—it's a necessary step toward accurate medicinal use, regionally grounded plant documentation, and culturally resonant botanical education.

Keywords: Botanical Identity, Fagonia cretica, Mediterranean species, Specie mapping, Clarification

BOT-2006: Unraveling the Genetic Architecture of the Stay-Green Trait in Bread Wheat

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The golden ears of bread wheat have long been regarded as a symbol of global food security since the dawn of civilization. However, the combined pressures of climate change, decreasing arable land, and a rapidly growing population pose significant challenges to wheat production. In response, wheat breeders are actively engaged in exploring various approaches to enhance crop productivity while minimizing environmental impact. Among these, the stay-green trait has emerged as a promising characteristic, offering improved resilience and yield stability. The stay-green trait, allows crops to maintain chlorophyll levels and

sustain photosynthetic activity over extended periods, thereby maximizing the grain filling duration and ensuring yield stability, especially under stress conditions. This study investigates the genetic architecture of the stay-green trait in wheat by evaluating a diverse germplasm that includes Landraces, Green Revolution, Post-Green Revolution, and elite cultivars. The morpho-physiological traits assessed were chlorophyll content, chlorophyll fluorescence, NDVI, plant height, tiller number, spike length, spikelets per spike, thousand kernel weight, grain yield, and biological yield. A Genome-Wide Association Study was performed using three statistical models: General Linear Model, Mixed Linear Model, and Fixed and Random Model Circulating Probability Unification. The analysis revealed significant genotypic variation and strong positive correlations between stay-green indicators and grain yield. The GWAS identified 83 marker-trait associations across 48 genomic loci. Gene annotation revealed 36 candidate genes connected with stress tolerance and chloroplast development underlying the identified loci. These insights provide a foundation for future breeding efforts targeting the stay-green trait to enhance yield stability under adverse environmental conditions.

Keywords: Wheat; Stay-green trait; Yield stability; Genome-Wide Association Study

BOT-1780: Antioxidant and Phytochemical Analysis of Clematis montana Leaves Extract

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Plants are a natural supply of chemicals, nutrition and a variety of medications. In recent years, there has been increased interest in the therapeutic and nutritional components obtained from plants because of their biological activities. The current study was aimed to examine the different phytochemicals as well as the antioxidant, phytotoxic and cytotoxic properties of *Clematis montana* leaves because of the medicinal importance of plant. The phosphomolybdate assay and the DPPH radical scavenging assay were used to investigate the antioxidant potentials of leaves extracted with ethanol, chloroform and acetone. Significant antioxidant capacity was demonstrated by the plant, particularly by the ethanol extracts (91.09%) and acetone extract (89.91%), which had the highest antioxidant percentage as compared to the chloroform extract (73.04%). In the brine shrimp lethality assay for cytotoxicity evaluation, the extracts of acetone (20.15µg/ml) and ethanol (22.71µg/ml) had the lowest LC_{50} values as compared to chloroform (34µg/ml). In case of phytotoxic assessment, the lowest concentrations of ethanolic extract showed mild inhibition of germination, the highest concentrations of chloroform showed the highest inhibition of germination, and the lowest concentration of acetone extract showed the strongest inhibition. The root inhibition (%) and shoot inhibition (%) showed the same level of activity. The presence of various phytochemicals, including flavonoids, alkaloids, tannins, saponins and phenols was verified and measured. The results

indicated that the ethanol extract of *Clematis montana* leaves contained the highest concentration of flavonoids (101 mg/g) and the lowest concentration of alkaloids (24 mg/g). It is concluded that *Clematis montana* plant's leaves are effective source of various phytochemicals and nutrients, as well as having strong antioxidant potential. So, this plant can be used in a variety of medicinal products and enhance daily nutritional intake, thereby preventing various forms of nutritional deficiencies.

Keywords: Medication, phytochemicals, LC_{50}, therapeutic, antioxidants, phytotoxic, cytotoxicity

BOT-1577: Phytofabrication of multifunctional iron oxide nanoparticles their Bio-Potential

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The emergence of nanotechnology revolutionized the modern world as it is an integrated field of science which has transformed the industries, presented efficient energy solutions and helped us getting different devices and treatment in the field of medicine. The production and utilization of nanoparticles (NPs) demonstrates significant advancement in nanotechnology owing to the distinct physicochemical characteristics of NPs including high surface area-to-volume ratio and enhanced reactivity. The antimicrobial together with antioxidant, anti-larvicidal, antileishmanial and anticancer properties and catalytic attributes of iron oxide nanoparticles (IONPs) make them attractive for various applications. The traditional nanoparticle synthetic practices employ toxic substances and excessive energy has drawn criticism because they have sustainability challenges and has adverse environmental and health impacts. This research study demonstrates the fabrication of *Saxifraga flagellaris* sourced IONP aqueous extract because this plant has medicinal importance and pharmacological properties. Different analytical tools such as UV- Visible spectroscopy, SEM, XRD, FTIR confirmed the formation, crystalline structure, size, morphology and adsorbed functional groups on the synthesized nanoparticles. The average size of 22.66 nm was recorded utilizing sharp peaks of XRD spectra. The scanning electron micrograph revealed round shape and agglomerated nature of *S. flagellaris* mediated IONP. The narrow and distinct peaks of FT-IR exhibits the presence of Fe-O, C-C, C-O, C-N, C-H, C=C, C-OH and O-H functional moieties up on particle surface. Furthermore, different bioactivities revealed significant potential of our greenly synthesized NPs. The disc diffusion technique confirmed promising bactericidal and fungicidal activities against all selected microbial strains. The asynthesized nanoparticles displayed moderate potential against HepG2 liver cancer cells and significant potency against brine shrimps (IC50: 33 %). Additionally, the *S-*

Flagellaris sourced IONPs successfully degraded 63% selected azo dye; methylene red dye. Overall, the fabricated *S flagellaris*-IONPs have shown potential bioactivities and need to be further evaluated for in depth in-vitro and in-vivo investigations to create pharmaceutical or dug formulation.

Keywords: Saxifraga flagellaris-IONPs, antimicrobial activities, antifungal activities, anticancer activity.

BOT-1589: Deciphering Ethno-Pharmacological Potentials of *Astragalus anisacanthus* Leaves extracts

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Among the different parts of the words, medicinal plants are playing a very essential role in health care services for the treatment of various diseases. According to WHO, 60% of the population of the world is dependent upon on folk medicines and 80% population of developing countries is totally dependent on natural plants for herbal medicines. Herbs have been the major source of food and medicine. Recently, different bio-active compounds like phenol, alkaloids, flavonoids, saponins, quinones, enzymes and triterpenes present in several plants, have been the core of research due to their advantages for human health. The objective of current study is to investigate the various biological activities; anti-fungal, antibacterial, dyedegradation and antioxidant assays of aqueous extract of plant species *Astragalus anisacanthus* collected from Dir Munda, Pakistan. The different functional moieties; C=C, C-H and N-O from the *A. anisacanthus* sourced methanol-, ethanol-, Ethyl acetate and n-hexane extracts were confirmed via FT-IR analyses. Further, our as prepared *A. anisacanthus* mediated extracts have shown promising bactericidal and fungicidal activities. The significant potential of our asynthesized crude extracts were recorded against methylene red dye. The *A. anisacanthus* sourced n-hexane illustrated highest degradation potency of 94 % followed by 80.65 % Ethanol extract, 74 % in Chloroform and 57.06 % by *A. anisacanthus* sourced methanol extract. The anti-radicle activity demonstrated promising potentials of *A. anisacanthus* inspired methanol extract; DPPH: 81.34 µg/mL, TRP: 79.34 µg/mL, TAC: 81.56 µg/mL. The future studies can fully harness the detailed therapeutic potential of the bio-active compounds of *A. anisacanthus*.

Keywords: A. anisacanthus, antimicrobial activity, brine shrimp activity, dye degradation activity, antioxidant activity

BOT-1601: Phytochemical Constituents and Bioactive Potential of *Grewia optiva*'s Fruits and *Justicia adhatoda*'s Flowers

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Medicinal flora is being extensively diversified worldwide and is being studied pharmacologically for its bioactive components and floral derivatives. These are widely used to progress the pharma business globally and treat deadly diseases. They may also serve as a source of natural medications. The current research was solely focused on in vitro phytochemical, biological, antioxidant, antibacterial, and cytotoxic analysis of chloroform and methanolic extracts of novel plant parts: fruits of G. optiva (Tilliaceae) and flowers of J. adhatoda (Acanthaceae). The present study showed that the plant parts are highly medicinal. J.adhatoda's methanolic extracts have the highest phenolic content calculated by Folin-ciocalteu assay whereas G.optiva's high flavonoid content estimated by aluminum chloride method was in its chloroform extract of fruit. Antioxidant potential was assessed by 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay, phosphomolybdenum and Total Reducing Power assay, and the results clarified that maximum potential was shown by methanolic extract of flowers of J. adhatoda. Antibacterial potential was evaluated against six strains and the results for methanolic extracts of fruits of G.optiva were found to be remarkable against B. subtilis, S. sapriophyticus, and E.coli. Likewise, the highest cytotoxic potential was shown by the chloroform extract of J. adhatoda of the flower. Assays using Fourier Transform Infrared Spectroscopy are useful for documenting the functional groups present in plant extracts. Future research should thus concentrate on separating the plant's bioactive components and assessing them in vivo on model organisms; this might be a significant development for the pharmaceutical sector.

Keywords: G. optiva and J. adhatoda crude extracts, DPPH assay, TAC assay, TRP assay, FT-IR analysis.

BOT-1736: *In Silico* Analysis of Purified Bioactive Compounds of Selected Solanaceous Species Against Cancer

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Cancer remains a major global health challenge, contributing significantly to mortality despite advances in chemotherapy, radiotherapy, and immunotherapy. Treatments often encounter limitations such as drug resistance, toxicity, and relapse, underscoring the need for safer and more effective alternatives. Plant-derived bioactive compounds have attracted growing interest due to their diverse pharmacological activities and relatively low toxicity. This study evaluates the anticancer potential of two medicinally important Solanaceous plants, Cestrum aurantiacum L. and Solanum elaeagnifolium L., using in silico approaches. Cestrum aurantiacum is noted for its antimicrobial and anti-inflammatory constituents, while Solanum elaeagnifolium (silverleaf nightshade) has traditional applications in pain and inflammation management and possesses pharmacological significance. Four isolated compounds beta-amyrin, lupeol,

Tris(2,4-di-tert-butyl) phosphite, and 2-Pentadecanone, 6,10,14-trimethyl and subjected to molecular docking against protein targets associated with nine major cancer types: blood, bone, liver, lung, thyroid, breast, oral, stomach, and kidney cancers. Docking results revealed strong binding affinities for beta-amyrin against oral cancer protein (5g5j) -17.8, lupeol against liver cancer protein (8szl) - 15.6, and Tris(2,4-di-tert-butyl) phosphite against blood (7uda), bone (3kry), and kidney (3voy) cancer proteins are 15.8, while 2- Pentadecanone, 6,10,14-trimethyl showed weaker activity against breast cancer protein (2cgy) -4.4. Pharmacokinetic (ADME) analysis indicated excellent properties for 2-Pentadecanone, moderate properties for beta-amyrin and lupeol, and poor results for Tris(2,4-di- tert-butyl) phosphite. Drug-likeness evaluation confirmed beta-amyrin, lupeol, and 2-Pentadecanone as favorable, whereas Tris(2,4-di-tert-butyl) phosphite failed to meet essential criteria. Overall, beta-amyrin and lupeol emerged as promising candidates due to their strong binding and drug-like features. Despite excellent pharmacokinetics, 2- Pentadecanone's weak binding limits its potential, while Tris(2,4-di- tert-butyl) phosphite lacks necessary pharmacological attributes. This study highlights the role of computational tools in identifying plant- derived anticancer agents and supports further exploration of Solanaceous species in cancer drug discovery.

Keywords: Cancer, beta-amyrin, lupeol, Tris (2,4-di-tert-butyl) phosphite, 2-Pentadecanone, 6,10,14-trimethyl, Molecular docking, Drug-likeness, pharmacokinetics.

BOT-1823: Phytochemicals and Pharmacological Activities of *Trifolium repens* L. Extract

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Trifolium, one of the major genera in the fabaceae family, well-known for its 300 species and use in agriculture. The European perennial herbaceous Trifolium repens, commonly called shaftal or white clover, has white flower heads, spreads rapidly and flourishes on moist soil and sunlight. T. repens, a traditional plant with high protein content, offers high-quality forage, soil health improvement, erosion reduction, green manure, antibacterial, antiinflammatory, antioxidant and medicinal properties is used to treat stomach pain, joint disorders, coughs, colds, fever, and eye wash. This study investigated antioxidant properties, cytotoxic, phytotoxic and phytochemical composition of T. rapens evaluated by using various methods. This study revealed the presence of bioactive compounds like flavonoids, phenolics and tennins with significant antioxidant, cytotoxic and phytotoxic effect in various assays. The results showed that ethanol extract, despite slightly higher %RSA values at higher concentrations, had the highest IC_{50} value (519.3 µg/mL), making it the least potent. The hexane extract and chloroform extract demonstrated the highest antioxidant activity, with absorbance values nearly matching ascorbic acid at higher doses. The chloroform extract

demonstrated the highest antioxidant potential, with absorbance values reaching 1.762 at 400 µg/mL, nearly matching the standard ascorbic acid value of 1.788 at the same concentration. All three Trifolium repens extracts showed dose-dependent cytotoxicity in the brine shrimp assay. The hexane extract was most potent caused 80 %mortality followed by ethanol and chloroform, capable of inducing higher levels of mortality at lower concentrations. Phytotoxic evaluation found that hexane extract inhibited growth at 50 µg/mL, while ethanol and chloroform extracts promoted root growth at 25 µg/mL and 5.02 cm respectively. Results were statistically analysed using LD50 for regression line calculation. This study explored the medical potential of plant, possibly aid for drug development in the pharmaceutical industry, potentially validate traditional utilization of Trifolium rapens and revealed its active extract.

Keywords: Trifolium rapens, phytochemical analysis, antioxidant activity, phytotoxic effects, Mediterranean region, natural product.

BOT-1929: Eco-Friendly Synthesis of Iron Oxide Nanoparticles using O*puntia dillenii*, Characterization and Bioactivities

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In the current research work, bioactive components present in *Opuntia dillenii* fruit extract were utilized for the synthesis of IONPs using iron acetate as precursor salt. The newly formed IONPs were extensively characterized for their physiochemical properties using different analytical tools; UV-Vis spectroscopy, SEM, EDX, FT-IR, and XRD. The crystalline nature of IONPs was confirmed by XRD analysis and the average size was calculated 27.7 nm. Further, *in vitro* studies were performed to reveal biological potentials. Antibacterial assay of biosynthesized IONPs was performed against different bacterial strains (*Staphylococcus saprophyticus, Enterococcus faecalis* and *Rhodococcus jostii*) and zone of inhibition (ZOI) were measured and MIC values for all strains was reported as 31.25 µg/mL. The IONPs showed antifungal activity against different fungal strains (*Aspergillus niger, Aspergillus flavus, and Candida albicans*). The MIC value for *Aspergillus niger* and *Candida albicans* was reported as 100 µg/mL and described as the most susceptible strains while *Aspergillus flavus* was reported as the most resistant strain MIC: 300 µg/mL. To evaluate the cytotoxicity assay against newly hatched nauplii of brine shrimps, Vincristine sulfate served as positive control. The results for IONPs was recorded as 41.73 µg/mL while 4.011 µg/mL was reported for positive control vincristine sulphate. Overall, the current study has demonstrated the utilization of *Opuntia dillenii* fruit extract for IONPs fabrication by designing an eco-friendly and forthright alternative to traditional approaches for IONPs synthesis.

Keywords: Opuntia dillenii, Iron oxide nanoparticles, Cytotoxicity, antibacterial, antifungal

BOT-1405: Toxicity Assessment of Nannorrhops ritchiana Extract In Vitro and Phytochemical Analysis

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Herbal medicines are widely used in developing countries and are of great demand for primary medical assistance because of their traditional acceptance, low cost and minimum side effects therefore, they have extremely high extent of compatibility with in body. *Nannorhops ritchiana* Griff (Arecaceae) is a clumping palm, edible and frequently used xerophytic shrub to small tree dispersed in Pakistan. In current study, phytotoxicity assessment of *Nannorrhops ritchiana* leaves extract was evaluated through Radish seed germination assay, cytotoxicity was determined by performing Brine shrimp lethality assay, and antioxidant activity was measured by using 2,2-diphenyl-1- picrylhydrazy (DPPH) free radical scavenging assay as well as qualitative phytochemical screening was carried out for the evaluation of bioactive compounds that were responsible for toxicity. The results showed that the methanol leaf extract of *Nannorrhops ritchiana* acquired significant phytotoxicity with radish root length inhibition of 80%. Qualitative phytochemical screening revealed that the presence of alkaloids, flavonoids, saponins, carbohydrates, tannins, terpenoids, polyphenol, phenolic compounds, glycosides, aminoacids and absence of anthraquinones. The extract had moderate cytotoxic effects for brine shrimp with the LD_{50} of 252.1 μgml^{-1}. Moreover, the methanol leaf extract exhibited strong antioxidant activity for DPPH with IC_{50} value of 3.816 μgml^{-1} that indicates their significant use for the cure of oxidative stress-related ailments.

Key words: Nannorrhops ritchiana, Antioxidant, Cytotoxicity, Phytotoxicity

BOT-1793: Microplastic Degradation by Using Bacterial Strains and Its Impact on Plant Growth

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Microplastic contamination is now a salient environmental issue considering its durability, being non-biodegradable, and severely detrimental to soil health and plant growth. The current study sought to isolate and characterize bacteria with potential to degrade PET microplastic and use degraded plastic to evaluate its impact on plant growth. The strains with plastic degrading ability were isolated from Coastal regions of Pakistan. The strains were used in laboratory to degrade microplastic at 35-37^{o}C. PTQ strain degraded microplastic upto 62.5%, while 46.5 % degradation was degraded with strain GDN. PTQ is closely related to *Exiguobacterium mexicanum* bacteria as evident from 16S RNA sequencing and phylogenetically closely related to *E. mexicanum.* The morphological changes of plastic after degradation were confirmed with SEM, while FTIR was used to study chemical structural changes, establishing the effective degradation of PET by the

bacterial strain. Furthermore, *Brassica juncea* (mustard) was selected to study the effect of treated microplastic on plant growth. The results showed that plants grown in degraded PET showed significant enhancement in growth parameters, including root length, shoot length, fresh and dry biomass as compared to untreated PET microplastic plants. The present research establishes a basis for potential application of PET degrading bacteria towards alleviation of microplastic pollution and negative impacts of plastic on plant growth. The results suggested that these bacteria after further investigation could be effectively utilized to degrade PET microplastic and degraded plastic could be safely dumped into soil without effecting plant growth.

Keywords: PET, biodegradation, bacterial strains, SEM, FTIR, Brassica juncea, plant growth

BOT-2071: Harnessing Ligninolytic Fungi for Sustainable Remediation of Heavy Metals

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Heavy metal contamination of soils poses a serious threat to environmental and human health due to the persistence and non- biodegradability of metals such as cadmium (Cd), lead (Pb), chromium (Cr), copper (Cu), and nickel (Ni). Bioremediation using white rot fungi (WRF) represents an eco-friendly and cost-effective alternative to conventional physicochemical methods. White rot fungi, including Phanerochaete chrysosporium, Pleurotus ostreatus, Trametes versicolor, Ganoderma lucidum, and Lentinula edodes, possess remarkable capabilities to tolerate and detoxify heavy metals through biosorption, bioaccumulation, and enzymatic transformation. Their ligninolytic enzyme system comprising lignin peroxidase (LiP), manganese peroxidase (MnP), and laccase plays a vital role in the oxidation and transformation of metal complexes, reducing their bioavailability and toxicity. The extensive mycelial network of these fungi enhances soil aggregation and facilitates immobilization of metals by binding them to fungal biomass or organic matter. Moreover, the extracellular polymeric substances (EPS) secreted by WRF further contribute to metal sequestration. Previous Studies have demonstrated efficient removal rates of Pb (up to 85%), Cd (70–80%), and Cr (75%) by T. versicolor and P. chrysosporium in contaminated soils. The integration of WRF-based bioremediation with organic amendments or plant-assisted systems (myco-phytoremediation) offers great potential for restoring degraded soils. Thus, the use of white rot fungi constitutes a sustainable and promising strategy for mitigating heavy metal pollution and promoting environmental resilience.

Keywords: Heavy metal contamination, Persistence, White rot fungi, Ligninolytic enzyme system, Bioremediation

BOT-2072: Root-Knot Nematode the Hidden and Mysterious Plant Pathogen

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Root-knot nematodes (*Meloidogyne* spp.) are among the most destructive plant-parasitic nematodes, causing significant yield losses in tomato and other crops worldwide. *Meloidogyne enterolobii* is of particular concern due to its aggressive nature, wide host range, and resistance-breaking ability. This study evaluated the efficacy of selected non-fumigant chemical nematicides (Fluensulfone, Fluazaindolizine, Fluopyram, and Oxamyl) and bionematicides (lignin- alkali at two concentrations and Majestene) for the management of *M. enterolobii* in greenhouse-grown tomato. Tomato plants were inoculated with 29,400 eggs per pot, followed by nematicide drench applications. Parameters measured included root galling index, nematode reproduction factor, egg density, and plant growth traits. Results indicated that Fluensulfone significantly reduced galling, egg density, and reproduction factor, while Fluopyram improved shoot growth and Oxamyl enhanced root growth. Among bionematicides, the high-concentration lignin-alkali treatment effectively suppressed nematode infestation and promoted plant growth. These findings highlight the potential of integrating chemical and biological nematicides into an integrated nematode management (INM) framework, offering sustainable alternatives for tomato production in the absence of fumigants.

Keywords: Meloidogyne enterolobii, tomato, root-knot nematode, nematicides, bionematicides, integrated nematode management (INM), plant-parasitic nematodes.

BOT-1588: Phytosynthesis of NiO NPs using *Anaphalis margaritacea* and its In-*vitro* Pharmacological Potential

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Nanotechnology deals with the synthesis of physical, chemical and biological systems at scales ranging from single molecules and atoms to small sizes and also combining the resultant nano-materials into more complex structures. The developments generated by nanotechnology possess significant contributions in the industrial and technological sectors involving medical, electrical, agricultural, homeland security, food safety and electronic technologies. Changes in the shape, size, surface, charge and surface area to volume ratio of nanostructures offers NPs their distinctive characteristics that enable their utilization in a variety of multidisciplinary areas. The current study deals with the detailed synthesis of *Anaphalis margaritacea* sourced NiONPs. The fabrication of *Anaphalis margaritacea*-NiONPs was confirmed via different characterization techniques and analysis tools. Different biological activities like anti-microbial, anti-oxidant

and dye-degradation assay of asynthesized NiONPs was also investigated. After successful synthesis of NiONPs the biological applications were performed and analyzed by utilizing different software. The *Artimia salina* cytoxicity assay illustrated 77 % inhibition at 1000 µg/mL with IC50 value of 13.20 revealing good cytotoxicity potential. The *A. margaritacea*-NiONPs exhibited excellent bactericidal potential on almost all concentrations. The as prepared green nanoparticles showed significant dye degradation potential (88 %). The potential antioxidant activity of *A. margaritacea*-NiONPs is attributed to the presence of reductones adsorbed up on the surface of our nanoparticles. The fungicidal assays for *A. margaritacea*-NiONPs revealed significant activities against selected fungal strains. On the whole, our NiONPs exhibited potential bioactivities and can be used by pharmaceutical industries after complete in-vivo and in-vitro trials. Moreover, the fabrication mechanism is also new frontier in research.

Keywords: Anaphalis margaritacea-NiONPs, antimicrobial activity, brine shrimp activity, dye degradation activity

BOT-1604: *Rhamnus virgata* mediated crude extracts and their biological potential

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The medicinal plants have been utilized since the dawn of human era around the globe to diagnose, treat and control various simple to dreadful ailments. It is matter of fact that a huge number of contagious diseases have been treated using medicinal plants throughout the history of human beings. There are various strategies (allopathy, radiotherapies, chemotherapies etc.) that help us to treat diseases, but these methods encompass several adverse reactions to human bodies. Bioactive chemicals/secondary metabolites; glycosides, flavones, steroids, alkaloids and many other compounds with prominent therapeutic action are abundantly found in medicinal plants. The current study explored the various bioactivities of green and active substances present in the different crude extracts of selected plant; *Rhamnus virgata*. The polar and nonpolar *R. virgata* sourced crude extract was examined for anti-antimicrobial, antioxidant and dye degradation properties. The present study revealed that the RV methanolic extracts were most potent among all prepared crude extracts. Furthermore, the current study reported excellent antibacterial activity. The significant anti-radical potential was recorded including DPPH test [methanolic extract (85%) ethanol (80%), chloroform (66%) and n hexane (61%)] and TRP [methanolic extract (90%) followed by ethanol (80%), chloroform (65 %), and n hexane (60%) at the maximum dose of 1000 µg/ml. Also, the RV sourced crude extract displayed significant dye degradation in RV mediated methanol extract (66%) followed by RV-ethanol extract (56%). In future, the research scientists can focus on different

unexplored medicinal plants sourced crude extracts, more *in-vitro* and *in-vivo* experiments exploiting different models, compounds isolation and drug discovery.

Keywords: Medicinal Plants, Bioactive Compounds, Bioactivities, Antimicrobial, Antioxidant, Dye degradation

BOT-1964: Exploring pharmacological applications of Phytofabricated Zinc Oxide Nanoparticles

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The vast applications and utilization of greenly synthesized nanoparticles at commercial level have revolutionized nano-pharma industries due to enhanced bioavailability, and reduced toxicity. The nanodrugs delivery systems that are obtained from natural resources are more effective, soluble, safe and stable than chemically derived nanosystems. Bioinspired nanomaterials obtained by green synthesis including metal oxide or metal and hybrid nanoparticles are environment friendly, unharmful and safer to be employed in biomedicine. The phyto-fabrication is ecofriendly, cheap and is a potential alternative to traditional routes for fabricating nanostructures. The current study involves fabrication of *Lactuca polycephala* mediated zinc oxide nanoparticles. The functional moieties and green chemicals from *Lactuca polycephala* are believed to reduce salt used for the preparation of nanosized particles. The asynthesized green nanoparticles were validated UV-Vis (Ultraviolet-Visible), XRD, SEM, FT-IR (Fourier-transform infrared). The mean size of the *L. polycephala* sourced zinc oxide nanoparticles was found to be 18 nm. The significant bactericidal properties of as-prepared NPs was recorded which was demonstrated using different bacterial strains. The promising antifungal potency was reported for our *L. polycephala* sourced zinc oxide nanoparticles. Cytotoxicity assessment of *L. polycephal*a-ZnONPs against nascent hatchling revealed concentration-dependent response. The synthesized green NPs revealed significant antioxidant potential confirming the attached reductones upon the surface/interface of ZnONPs. In conclusion, our greenly fabricated nanoparticles have shown significant *in vitro* bio-potentials. In future, the mechanistic applications and devising of scalable methods should be focused to fully explore the potential of *L. polycephala* sourced nanoparticles.

Keywords: L. polycephala-ZnONPs, antifungal activities, antimicrobial activities, antibacterial activities, anticancer activity.

BOT-2061: Salicylic Acid and Moringa Seed Extract Mitigate Chromium Induced Stress in Wheat By Restricting its Uptake and Improve Phytochemical Constituents

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Chromium has a significant impact on wheat growth, making it a serious global problem. The discharge of heavy metals into soil is a major global problem, they persist and disrupt our ecosystem. Due to higher nutrient content, wheat is the most significant and food cereal in the world. Salicylic acid is a powerful signaling molecule that activates plant's defense mechanisms under biotic as well as abiotic stressors including heavy metals, drought and salt stress. Maringaseed extract is a rich source of antioxidants and osmoprotectants. The research was done, in University of Gujrat, Pakistan. Salicylic acid seed priming and extract of moringa seed exogenously was used to study the harmful effects of chromium on wheat (*Triticum aestivum* L.) variety Sehar-06 and variety Johar-16. The finding signifies the two years data (2021 and 2022) of wheat. Total phenolic contents in root were highly increased (293.0, 291.33) with 3 % moringa seed extract and 3 mM salicylic acid in Johar-16 and also with high (1.0 mM) chromium stress in both years. Increased total phenolic contents in shoot were also noted at all levels of chromium (0.5, 0.75 and 1.0 mM). In both wheat varieties, the control showed the lowest total phenolic levels in seed (35.06, 36.21) in both the 2021 and 2022 years in Sehar-06. Maximum (57.75 and 59.33) total flavonoid content in root were recorded in non- stressed plants with salicylic acid seed (3 mM) and exogenous application of moringa seed extract (3 %) in both wheat varieties in comparison with non-sprayed plants.TFC decreased with increasing Cr stress. MSE helps in increase of TFC in shoot by 17.87 % in Sehar-06 and by 18.93 % in Johar-16 of non chromium treated plants. It was elaborated from results that Johar-16 gave best values of total flavonoid content in seed as compare to Sehar-06.

Keywords: heavy metals, chromium, seed priming, phytochemical constituents.

BOT-1648: Influence of *Bombax ceiba* L. based copper nanoparticles on wheat (*Triticum aestivum* L.) growth parameters

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Agricultural nanoparticles provide inspiring opportunities to better crop yields and stress resistance. Wheat (*Triticum aestivum* L.) is a globally important food crop with rising which requires expanding agricultural production area in a more sustainable manner. This study examined the biosynthesis of copper nanoparticles (CuNPs) using *Bombax ceiba* L. leaves extract. The researchers used UV-Vis spectroscopy, FTIR, SEM, and XRD to characterize the CuNPs and verified their functional groups, morphology, and purity. A preliminary study was performed in vitro using six concentrations (5,10,15,20,40 and 60ppm) of CuNPs on the Akbar-19 wheat variety and then germination percentage and growth parameters (length of root and shoot, fresh and dry weight of root and shoot) was recorded after 7 days. Based on the data from this trial, the ideal concentrations were identified using two concentrations (20 and 40 ppm). The study also treated five wheat varieties (Akbar-19, Barlaug-16, Wafaq-23,Pak-13, and NARC-Super) to identify

which would work best when exposed to CuNPs. Varieties namely Wafaq-23, and Barlaug-16 were chosen as representatives of the best performing varieties in the in-vitro study and were employed for the pot experiment including irrigation treatments representing three different conditions; normal (irrigation with water), drought (no irrigation), and saline (irrigation with 150mM NaCl solution) for 21 days . The priority growth attributes evaluated associated to these treatments were a combination of key physiological and morphological traits. The results showed significant variability and enhancement in growth parameters in Wafaq-23 under saline (irrigation with 150mM NaCl solution) and drought stress conditions. However, Barlaug-16 was adaptive to drought and saline's stress under low CuNPs concentration (20ppm). This finding has important agricultural applications for green synthesized CuNPs, suggesting different dose and condition responses and the possibility of genotypic differences in wheat varieties.

Keywords: UV-Vis spectroscopy, FTIR, SEM, XRD, Bombax ceiba L., Growth parameters.

BOT-1622: Unveiling the potential of Thorn Apple Oil Seeds for synthesizing Eco-friendly fuels

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Converting a poisonous, invasive weed into an environmentally friendly energy source provides a potent solution to achieve sustainability. Non-edible oil found in thorny apple (Datura stramonium) seeds has exceptional potential for the creation of sustainable biodiesel, despite being generally considered undesirable due to its toxicity. In addition to removing the conflict between food and fuel, this inedible feedstock gives value to a plant that is frequently written off as waste. Through improved transesterification procedures, the seed oil, which is abundant in long-chain fatty acids, can be effectively transformed into fatty acid methyl esters (FAME). It was discovered that its seeds have a 27% oil content and a 0.476% free fatty acid content. Bentonite clay, a clay-based nano-catalyst, was used in the transesterification reaction both in blank and calcined at various temperatures in order to maximize the quantity produced by thorn apple oil biodiesel. BT clay was analytically characterized using energy dispersive X-ray spectroscopy (EDX), scanning electron microscopy (SEM), and X-ray diffraction (XRD). When BT was calcined at 500 degrees Celsius, it produced 87% biodiesel, whereas blank BT was less effective for transesterification and produced 43% of biodiesel. Because the catalytic sites were blocked, BT calcined at 300°C produced 51% biodiesel, while BT calcined at 700°C produced 74%. Analytical methods such as Fourier transform infrared spectroscopy (FT-IR) analysis and GC-MS were used to further characterize the produced biodiesel. Additionally, the thorny apple seed biodiesel's fuel characteristics, including its density (0.910 kg/L), pour point (-9 oC), cloud point (-12 oC), flash point (76 °C), kinematic viscosity (4.87 @40 oC), sulphur content (0.0005% wt), and total acid number (0.169 mg KOH/gm), were found to be in compliance with ASTM protocols. As

a result, thorny apple seed oil becomes a new and ecologically safe feedstock that supports the idea of a circular bioeconomy and is consistent with sustainable energy standards.

Keywords: Invasive weed, Thorn apple seed oil (TAO), Clay-based nano-catalyst, ASTM protocols, circular bioeconomy.

BOT-1784: Valorization of Waste Cooking Oil into High-Yield Biodiesel via Potassium Hydroxide- Catalyzed Transesterification

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Growing energy consumption and environmental degradation are issues that compel clean renewable fuels to come into existence. Biodiesel is a great replacement for fossil fuels since it is renewable and biodegradable by nature with low emissions. In the current manuscript Waste Cooking Oil (WCO) was used as a sustainable feedstock for biodiesel production via base catalyzed transesterification using sodium hydroxide (KOH) as homogenous catalyst , major reaction conditions like methanol to oil ratio, catalyst dosage, temperature and reaction time were optimized carefully to maximize the efficiency. Biodiesel yield of 95% was obtained at these specified conditions which proves KOH catalytic effectiveness. The produced biodiesel was tested on fuel properties such as viscosity, density, flash point, and acid value found to be within international biodiesel standards (ASTM D6751 and EN 14214). These conclusions show that used cooking oil can be easily changed into a top-excellence green fuel, giving two benefits of waste handling and clean energy making. This helps the idea of a round economy by showing how a city waste flow can be turned into a useful and lasting energy source. .

Keywords: Biodiesel; Waste Cooking Oil (WCO); Transesterification; Potassium Hydroxide (KOH); Homogeneous Catalyst; Renewable Energy; Sustainable Feedstock; Circular Economy; Fuel Properties; Green Energy

BOT-1785: Eco-Friendly Biodiesel Production from Non-Edible Oil Seeds of *Acacia modesta*

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Biodiesel production from non-edible oil seed has gained tremendous attention around the globe due to its unique features that are biodegradable, cost-effective and easily available fuel ascompared to fossil fuels. The current study focuses on

the utilization of novel non- edible, highly rich oil seeds i-e *Acacia modesta* Wall. (Seed oil 60%; FFA 0.3mg KOH/g) for synthesizing eco-friendly biodiesel. A novel nano-catalyst Zinc doped Copper Oxide (Zn (CuO)) (synthesized hydrothermally) have been synthesized, and characterized through SEM (Scanning Electron Microscope), XRD (X-rays Diffraction), XPS (X-ray Photoelectron Spectroscopy), FT-IR (Fourier Transform Infrared Spectroscopy)) and employed successfully for producing biodiesel through single step transesterification. This catalyst exhibits excellent catalytic activities (*Acacia modesta* biodiesel 89.5% yield), recyclability (3 times reusability of Zn (CuO)) and stability making them sustainable candidates for synthesizing biodiesel under ideal conditions. Zinc-doped copper oxide (Zn (CuO) nano-catalyst yield 89.5% *Acacia modesta* Wall. seed oil into biodiesel using 1:6 methanol oil, catalyst dosage of 0.5 wt %, at 65°C temperature, and time of reaction as 180 min). The synthesized biodiesel was characterized via latest techniques FT-IR (Fourier Transform Infrared Spectroscopy), NMR (Nuclear Magnetic Resonance) and GC-MS (Gas Chromatography–Mass Spectrometry) etc to check the presence of methyl ester groups. The study confirms *Acacia modesta* biodiesel meets international standards (EN 14214, ASTM D6751, and GB/T 20828), proving suitable for automotive use and eco-friendly energy. It highlights the potential of Acacia feedstock with Zn–CuO nano- catalysts for sustainable large-scale biodiesel, recommending cultivation on barren lands to boost eco-sustainability and innovation.

Keywords: Biodiesel, Acacia modesta, Biodiesel, Zn (CuO), Fuel properties

BOT-1870: Sustainable Production of Bioenergy from Novel Non-Edible Seed Oil (*Prunus Cerasoides*) Using Bimetallic Impregnated Montmorillonite Clay Catalyst

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The present study investigates the performance of a homogeneous Cd–Mn catalyst in the cleaner production of biodiesel from the novel non-edible seed oil of *Prunus cerasoides* D. Don., containing 51.8% oil and a free fatty acid (FFA) content of 0.52 mg KOH/g. The catalyst was characterized using X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray (EDX), and Fourier Transform Infrared Spectroscopy (FTIR).Under optimized transesterification conditions— 4 h reaction time at 110 °C, a 10:1 molar ratio of methanol to oil, and 3% catalyst loading—the process achieved the highest fatty acid methyl ester (FAME) yield of 88%. The resulting biodiesel was further analyzed using FTIR, Gas Chromatography–Mass Spectroscopy (GC–MS), and Nuclear Magnetic Resonance (^{1}H, ^{13}C NMR).Fuel properties of the synthesized biodiesel were determined as density (0.8654 kg/L), kinematic viscosity (4.36 mm²/s), flash point (78 °C), cloud point (−8 °C), and pour point (−11 °C). All measured values were in accordance with China's GB/T 20828 (2007), American (ASTM D6751, D951), and European (EN 14214) biodiesel standards.Kinetic

analysis revealed that the transesterification reaction followed a pseudo-first-order model, with a correlation coefficient (R^2) of 0.9285, indicating a good fit with the experimental data. These findings suggest that the homogeneous Cd–Mn catalyst offers a cost-effective, stable, and highly efficient alternative for biodiesel synthesis, with strong potential for industrial application.

Keywords: Biodiesel, Prunus cerasoides, Biodiesel, Cd–Mn, Fuel properties

CHEMISTRY

CHE-1526: DFT and Multiconfigurational (CASSCF) Analysis of Electronic Structure and Bonding in Actinide Complexes

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The electronic structure of actinide complexes is interesting to explore due to the near degeneracies present in the valence orbitals and the ability of both the 5f and 6d orbitals to engage in bonding. In present work we have investigated the electronic structure of uranium-arene homoleptic complexes. This includes [U(naphthenelide)3]3- and [U(perylenide)3]3-and one heteroleptic complex of [U(anthracenide)3I]2-. Previous research has explored that the f orbitals on uranium and electrons from the arene can contribute to different types of bonding ranging from strong, highly covalent bonds to polarized donor-acceptor interactions between occupied orbitals on the ligand and empty orbitals on the metal. We have used a combined approach of DFT and multiconfigurational methods like CASSCF and complete active space second order perturbation theory (CASPT2), to study these complexes while ensuring that the electronic structure is properly described.

Keywords: Complexes, Electronic Structure, Polarized donor-acceptor interactions

CHE-2023: Selective Butyryl-cholinesterase Inhibitors from Biotransformation of Dihydrotestosterone

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Biotransformation represents a valuable strategy for the generation of structurally diverse libraries of bioactive molecules. The present study investigated the microbial transformation of dihydrotestosterone (DHT) with the objective of identifying potential cholinesterase inhibitors. Employing whole-cell cultures of *Macrophomina phaseolina* and *Gibberella fujikuroi*, eight structurally distinct derivatives were obtained. Transformation by *M. phaseolina* yielded two previously characterized metabolites, while six known compounds were produced via transformation with *G. fujikuroi*. Among these metabolites, three exhibited

significant and selective inhibitory activities against the butyryl cholinesterase (BChE) enzyme. Furthermore, molecular docking simulations demonstrated strong concordance with experimental results, providing theoretical validation and mechanistic insights into enzyme ligand interactions. Given the central role of cholinesterase inhibition in the therapeutic management of Alzheimer's disease (AD), these preliminary findings, corroborated by *in silico* analyses, offer promising leads for the development of more potent and selective cholinesterase inhibitors as potential candidates in AD treatment.

Keywords: Microbial transformation, Dihydrotestosterone, Butyrylcholinesterase inhibition, Alzheimer's disease, Molecular docking simulation

CHE-1970: Synthesis and Characterization of Ni-Bi2O3 Nanoparticles for Photocatalytic Wastewater Treatment

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The increasing discharge of synthetic dyes from textile effluents poses a serious threat to aquatic ecosystem and human health. Conventional wastewater treatment methods such as adsorption, coagulation and biological processess are often limited by secondry pollution and incomplete dye removal. Heterogenuous photocatalysis has emerged as a sustainable and effficient alternative for degrading persistent organic pollution under light irradiation. In this study, pure and Nickel doped Bismuth Oxide (2&4% Ni-Bi_2O_3) nanoparticles were synthesized via a simple precipitation method and evaluated for their photocatalytic performance. The prepared nanoparticles wer characterized using various advance techniues to understand the structure and activity of the catalyst. The photocatalytic efficiency was assessed for the degradation of Malachite Green (MG) and Methyle Blue (MB) dyes under visible light. Among all the catalyst , 4% Ni- Bi_2O_3 exhibited the highest degradation effiecieny, achieving 98% removal of MG and 78.98% of MB under optimized reaction condition (3 mg catalyst dosage, 20 µM MG/ 18µM MB concentration, pH 9). Kinetic analysis confirmed the psudo-first-order behavior. Overall, the study demonstrates that Nickel doeped bismuth oxide nanoparticles are effective photocatalyst for dye degradatio, highlighting theor potential aas an eco-friendly strategy for wastewater treatmetnt and reuse.

Keywords: Photocatalysis, dye degradation, Bismuth Oxide

CHE-1911: Converting Waste to Use: Nanocellulose Extracted from Waste Cardboard

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Pakistan grapples with a massive problem of massive municipal solid waste (MSW) management. The abundance of organic solid waste contributes to environmental degradation. Thus, effective strategies for MSW management are essential. We report the extraction of cellulose from waste cardboard and its conversion to cellulose nanofibres (NC), with high surface area, thermal and mechanical stability, and biocompatible nature. XRD confirmed the extracted nanocellulose as cellulose type I with 61% degree of crystallinity. The size and zeta potential of NC was found to be 733 nm and 4.67 mV, respectively. Since the dispersion of NC poses a problem but is necessary for the purpose of application, a pyridinium based ionic liquid [C4Py] [Cl] (PyIL) was synthesized as the green solvent. The ionic liquid was characterized by nuclear magnetic resonance (NMR), FTIR and ultraviolet visible (UV-Vis) spectroscopy. The dynamic viscosity and density of the PyIL was found to be 560 mPas-s and 0.895 g/cm^3 at room temperature. Anti-microbial activity of NC, PyIL and cellulose dissolved ionic liquid (CIL) was investigated by broth dilution method against gram positive strains (Bacillus Subtilis and S. Aureus) and gram negative strains (K. Pneumoniae and E.Coli). Antioxidant activities of these compounds were analyzed using DPPH and FRAP assays. The best antioxidant activity was shown by CIL with 24.98% radical scavenging activity (RSA) against DPPH and 549.92 µg/mL of ascorbic acid equivalent per mg of sample. Excellent hemolytic inhibition activity was shown by CIL with a highest value of 150%. Results indicate that the anti-microbial, anti-oxidant and hemolytic inhibition activities of NC were greatly enhanced upon dissolution in PyIL.

Keywords: Sustainable Development Goals, Biomass Valorization, Nanocellulose, Ionic Liquid, Hemolytic Assays

CHE-1988: Rare Earth Nd-doped NiFe2O4 and its Composite with CNTs to Tune the Photocatalytic Activity

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Rare earth doped spinel nanoferrites are attaining importance as heterogeneous nanocatalysts for the degradation of organic effluents. Rare earth metal doping increases electrical, optical properties and surface to volume ratio of the bare sample. In this work, NiFe2O4 (NF) and Nd-NiFe2O4 (NF-1) was successfully synthesized via co-precipitation route. CNT based nanocomposite (NF-2) was prepared using ultra-sonication method. The prepared materials were analyzed via various physiochemical approaches. The degradation efficiency of these materials was analyzed for the degradation of Rhodamine B, methylene blue, and benzoic acid. NF-2 showed highest efficiency among all the prepared catalysts. It showed

83.87 %, 90.80 %, and 66.96 % degradation of Rhodamine B, methylene blue, and benzoic acid respectively. The reason for the superior activity of NF-2 is the existence of rare earth Nd ions and CNTs. The surface area of NF increases due to the presence of carbon nanotubes and enhanced surface area provides more active sites for the degradation reaction.

Keywords: XRD, Carbon Nanotubes, Benzoic Acid, Photo- Degradation, Visible Light

CHE-2042: Modified Hydrometallurgical Extraction of Copper from Low- Grade Ore Using Acid Leaching and Solvent Extraction

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The increasing demand for copper necessitates the utilization of not only high-grade but also lowgrade ores to ensure a sustainable metal supply. In this study, a locally available low-grade copper ore was processed using a hydrometallurgical approach with significant modifications compared to previously reported methods. The ore was ground to fine powder and characterized by X-ray fluorescence (XRF), which confirmed copper content as CuO (7.95%). Leaching experiments were carried out using sulfuric acid, nitric acid, and hydrogen peroxide as leachants, followed by microwave and UV irradiation to enhance dissolution. Unlike earlier studies, the solvent type and solvent-toaqueous ratio were modified to optimize copper extraction. The leach solution was filtered and subjected to solvent extraction in a separating funnel, where alternative organic solvents were tested in place of the conventional ones. The copper content in the organic phase was quantified by Atomic Absorption Spectroscopy (AAS). The results demonstrated that the modified method achieved improved copper recovery (approx. ~90% efficiency) compared to the reported procedure, highlighting the effectiveness of solvent and ratio optimization. These findings confirm that hydrometallurgical methods, when adapted through process modifications, can be effectively applied to low-grade copper ores, offering an environmentally viable and economically promising alternative to conventional pyro metallurgical processes.

Keywords: Copper extraction, Hydrometallurgy, Acid leaching, Solvent extraction, Low-grade ore, X-ray fluorescence (XRF), Atomic Absorption Spectroscopy

CHE-1814: Novel Antibacterial Activity of Nitro Group in Small-Molecule Sulphonamides against Antibiotic Resistant Uropathogenic *E. coli*

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Uropathogenic *Escherichia coli* (UPEC) causes urinary tract infections (UTIs) in approximately 150 millionpeople worldwide each year. It is estimated that 40%

of women will experience at least one UTI during their lifetime. UTIs are caused by a wide range of pathogens, including Gramnegative and Gram-positive bacteria presenting a significant public health challenge. *E. coli* is the predominant causative agent of both uncomplicated and complicated UTIs. In an era of increasing bacterial resistance to antimicrobial agents, coupled with a high prevalence of multidrug-resistant (MDR) strains in community and hospital-acquired infections, it is essential to re-evaluate existing antimicrobial agents. In this context, the use of Sulfamethoxazole derivatives appears to be a reasonable approach. This study aimed to evaluate the activity of newly synthesized fluorinated sulfonamides against common uropathogens, comparing them to the widely used Sulfamethoxazole and other antimicrobial agents routinely used for UTI treatment. The bactericidal activity of our sulfonamide compounds against resistant UPEC strains was assessed by determining the Minimum Inhibitory Concentration (MIC) and comparing their effectiveness to standard antibiotics. Wehypothesized that the synthetically prepared fluorinated sulfonamides would exhibit significant bactericidal activity against resistant UPEC strains. Among the compounds tested, Compound 4g demonstrated lower MIC values compared to Sulfamethoxazole when tested against Gram-negative bacteria, including clinical MDR *E. coli* strains. The MIC values for Compound 4g ranged from 62.5–125 µg/mL for Uropathogenic *E. coli* strains, while the MIC for Sulfamethoxazole exceeded 500 µg/mL for the same resistant strains. To identify the antibacterial component of the active compound, we performed activity assays with and without the presence of nitro groups. Our results showed that the nitro group was crucial for the compound's activity, as the removal of the nitro group from Compound 4g led to a complete loss of antibacterial activity. Therefore, our study confirmed that the antibacterial properties of Compound 4g are attributed to the nitro group, rather than the sulfonamide moiety.

Keywords: Multi drug resistant Bacteria, Sulfonamides, Uropathogenic E.coli, Minimum inhibitory Concentration (MIC), Nitro groups

CHE-1788: Iron Doped Nickel Oxide Based Graphene Nanocomposites for Electrochemical Sensing of Biomolecules

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Monitoring human health is of major clinical importance for early health disorders detection. Creating a flexible microelectrode that is graphene based having medical importance for biomolecules detection is better in fabricating electrochemical sensors for selective detection of dopamine, a crucial neurotransmitter. Dopamine sensors that are based upon noble metal nanoparticles and carbon based materials have been reviewed. Short reaction times as well as extremely sensitive, responsive, stable, and selective sensors have been in great demand so in the modern times composites based on graphene with metal based nanoparticles promotes these hybrid composites in large range biomedical applicability. Moreover, doping graphene derivatives having heteroatoms (Fe and

Ni) can changes their properties which are considered better in fabricating cost-effective sensors for practical utility. Facile preparation of Graphene oxide–Iron/Nickel oxide (GO– Fe/NiO) hybrid composite has been reported as it focuses on Fe doped NiO graphene oxide synthesis utilizing the co-precipitation method. Different properties of the composites were investigated bytechniques such as X-ray Powder Diffraction (XRD), Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectroscopy (FTIR) along with Energy Dispersive X-ray Spectroscopy (EDX). Techniques such as cyclic voltammetry (CV) and chronoamperometry (CA) are utilized in this studies for sensing dopamine. Fe-NiO/GO based flexible electrodes as sensors showed a linear dynamic range like 1.9 mM, sensitivity of 510 μA mM^{-1} cm^{-2} and a low limit of detection till 0.048 μM having a quick time of response that is 2s on lab scale testing. Such type of results supported that the microstructure sensors are cost effective, efficient and easily disposable electrodes that can be used for wearable sensing applications in future.

Keywords: Electrochemical sensors, Graphene oxide, Graphene nanocomposites, Nanohybrid, Dopamine Sensing, Electrochemical sensing, Doping, Flexible devices

CHE-2012: Transformative Trends in Food Science and Technology for Sustainable Nutrition

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Food science and technology have experienced notable development in recent years largely driven by the universal demand for safe, nutritious and sustainable food systems. Emerging innovations are reshaping the sector through the uptake of advanced practices, green technologies and novel delivery systems that improve food quality, safety and functional value. Cutting-edge approaches such as nanotechnology, 3D food printing, biotechnology and intelligent packaging are innovating conservation approaches extending shelf life and entitle the production of personalized and wholesome food products. At the same time, the affiliation of nutraceuticals, bioactive compounds and functional ingredients into food formulations has strengthened the connection between nutrition and preventive care, particularly in addressing noncommunicable diseases. Advances in analytical chemistry, foodomics and rapid detection methods are ensuring precise quality control, authenticity verification and attributability across the supply chain. Furthermore, digital technologies, artificial intelligence and data mining are paving the way for smart food systems that support predictive modeling, process optimization and market driven innovations. Sustainability remains as main focus with particular emphasis on alternative proteins, plant- based diets, closed-loop production and eco-friendly processing techniques designed to minimize environmental impact and depletion of resources. Despite these advancements, challenges remain in achieving consumer acceptance, regulatory coordination and cost- effective scalability. This review highlights the transformative trends carve food science and technology, presenting insights into their current applications, limitations and future potential in strenthening, innovative, and sustainable food systems for universal nutrition security.

Keywords: Food science and technology, Sustainable nutrition, Functional foods, Food innovation, green processing technologies

CHE-2013: Design, Synthesis, and Mechanistic Insights into the Antibacterial Activity of Alkylated Benzimidazoles

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As antibacterial resistance is increasing, there is an escalating need for the development of novel antibacterial agents with a unique mechanism of action. In medicinal chemistry, benzimidazole is renowned for its diverse properties. This study focuses on the design, synthesis, and evaluation of a series of *N*-alkylated benzimidazole derivatives for their in vitro antibacterial efficacy. The target compounds were efficiently synthesized and characterized using FTIR. Their

antibacterial activity was also assessed. Structural activity relationship (SAR) analysis revealed that the nature and position of different functional groups in the compounds are critical for their activities. The results indicate that the strategic alkylation of the benimidazoles warrants further investigation for combating resistant bacterial infections.

Keywords: Benzimidazoles, N-alkylation, Antibacterial, heterocyclic compounds

CHE-1615: Catalytic and Photocatalytic Efficacy of Metal Sulfide Nanostructures and Their Environmental Applications

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A series of brown-colored crystalline copper complexes were synthesized through simple chemical reactions. Both solvothermal and hydrothermal techniques were employed for the formation of nanoparticles. Ethylene diamine and octylamine, along with PEG, were utilized as solvents. All of the copper sulfide nanoparticles obtained exhibited a hexagonal morphology. Nanoparticles synthesized with octylamine as the solvent were smaller and exhibited superior crystallinity compared to those prepared with ethylene diamine. The particle size, morphology, phase purity, crystallinity, and elemental composition were analyzed using UV-Vis spectroscopy, X-ray Photoelectron Spectroscopy (XPS), X-ray Diffraction (XRD), Energy Dispersive X-ray Spectroscopy (EDS), and Scanning Electron Microscopy (SEM). These nanoparticles were further tested as catalysts and photo catalysts in dye degradation experiments.

Keywords: Ethylene Diamine, Octylamine, Nanoparticles, Copper Sulfide, PEG

CHE-1948: Innovative Catalytic Approaches for CO_2 Utilization: Green Fuels and Chemicals Production

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The global exertion has intensified for the development of sustainable technologies for carbon dioxide capturing and utilization (CCU) due to escalating atmospheric CO2 concentration, a significant threat to climate stability and global sustainability. Among various emerging techniques for CCU, electrocatalysis and photo catalysis has gained attention for emerging as promising techniques for converting CO2 to invaluable fuels and chemicals under mild reaction conditions immolating environmentally innocuous alternatives to traditional thermochemical processes. Recent advances in CO2 reduction technologies has extensively examined in this review accentuating catalytic systems that operate at ambient temperature and pressure while maintaining high selectivity and efficiency. The CO2 reduction by photocatalysis utilizes solar energy to drive the conversion process exploiting semiconductor materials such as TiO2, g-C3 N4 and metal-

organic framework as photocatalysts. Recent progress in plasmonic photocatalysts, Z-scheme heterojunctions and single atom catalysts substantially intensified light absorption, charge separation efficiency and product selectivity. In this process the major products, with product distribution controlled through catalyst design, co-catalyst selection and reaction environment application includes methanol, methane, carbon monoxide and formic acid. For CO_2 activation the electrocatalytic CO_2 reduction depicted as another remarkable pathway employing electrical energy to facilitate multi-electron transfer processes. The copper-based catalysts, transitional metal carbides (MXenes) and nitrogen-doped carbon materials are advanced electrode materials exhibiting remarkable performance in producing C_1 and C_{2+}. The incorporation of sustainable electricity sources makes this approach particularly attractive for sustainable chemical synthesis. Significant challenges reported in this review article include CO_2 activation mechanisms, competitive hydrogen evolution reactions, catalyst stability and scalability considerations. Modern advancements in interpreting structure-active relationships, reaction intermediates and mass transport phenomena have escorted the rational design of next- generation catalysts. The CO_2 conversion rates and energy efficiency have been improved by inventive reactive designs, including flow cells, gas diffusion electrodes and membrane electrode assemblies. Impending hybrid systems combining photocatalysis and electrocatalysis also discussed in this review illustrating synergistic effects that enhance overall performance.

Keywords: CO_2 utilization, photocatalysis, electrocatalysis, innovative catalytic approaches, sustainable energy carbon valorisation, renewable energy carriers

CHE-2070: New Picolylamine Template Organo-Catalyst for Enantioselective Aldol Reactions

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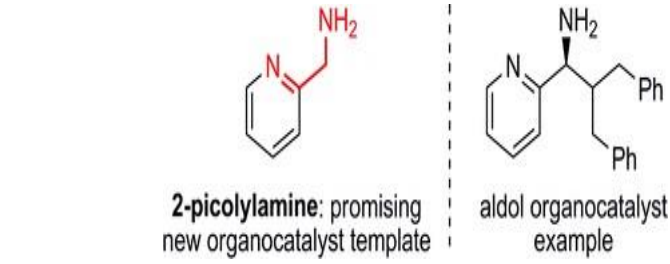
Picolylamine template organocatalyst containing only one stereogenic center has been identified for fast aldol reactions (16-48 h). Using 2–5 mol% of (*R*)- or (*S*)-PicAm-**2**, cyclohexanone (3.3 equiv) readily undergoes aldol reactions with *o*-, *m*-, and *p*-substituted aromatic aldehyde partners (limiting reagent), including the poor electrophile 4-methylbenzaldehyde (95–99% ee). Furthermore, functionalized cyclic ketone substrates have been converted into four aldol products 9–12 using the lowest catalyst loading (5.0 mol%) to date with the highest yield and enantioselectivity.



PicAm-**2**

Keywords: Picolylamine, Enantioselctive Aldol Reaction, Asymmetric Aldol, Oraganocatalysis

CHE-1767: Targeting Neuroinflammation: Novel Triazolo-thiadiazine Hybrids of Deferasirox for Alzheimer's Disease Treatment

Syed Ahmed Shakir[1], Umer Rashid[1*], Marryum[1], Nighat Fatima [2], Syeda Abida Ejaz [3], Ammara Fayyaz [3], Muhammad Zahid Ullah [1], Aamer Saeed[4], Ajmal Khan[5] ;Amara Mumtaz[1*]

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It is believed that inflammation influences several physiological processes, including the function of the central nervous system. Moreover, the impairment of lipid mechanisms/pathways is associated with neurodegenerative disorders and onset of Alzheimer's disease (AD). AD is a chronic neurodegenerative disease representing the major cause of dementia worldwide. In this case, the overexpression of different pharmacological targets has been confirmed to address neuronal inflammation and AD, with acetylcholinesterase (AChE), monoamine oxidase-B (MAO-B), cyclooxygenase-2 (COX-2) and 5-lipoxygenase (LOX-5) being the most explored targets. Currently, the available treatments are only capable of alleviating the symptoms and not capable of delivering disease-modifying effects. Thus, the current research objective is to synthesize triazolo-thiadiazine derivatives of the deferasirox drug as multi-target compounds that could concurrently inhibit ChEs, MAOs, LOX-5 and COX-2. The synthesized derivatives were confirmed by FTIR, ^{1}H NMR, ^{13}C NMR and DEPT-135 spectroscopic techniques. During in vitro investigations, compound 11 was found to be the most potent inhibitor of all the targeted enzymes. Briefly, this compound exhibited inhibitory values (IC_{50} ± SEM) of 0.31 ± 0.02, 0.13 ± 0.02 and 0.94 ± 0.11 µM against AChE, MAO-B and COX-2, respectively, suggesting that it is a lead molecule for the synthesis of more potential multi-targeted

inhibitors. Several compounds, such as compound 9 and 13, showed dual inhibition potential in comparison to standard drugs. Furthermore, molecular docking analysis was performed to validate the in vitro results, where the potent compounds showed some significant interactions with the key amino acids present in the active site of the targeted enzymes. Furthermore, molecular dynamics (MD) simulation data and physicochemical properties supported deferasirox-substituted triazolo- thiadiazine as a promising horizon for the discovery and development of new molecules to treat multifactorial diseases associated with neuro- inflammation, such as AD.

Keywords: Triazole, triazolthiadiazine, Alzheimer, Cholinesterase inhibitors

CHE-1632: Synthesis, Photophysical, Electrochemical, and DFT Studies of Chalcones for Photovoltaic Applications

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The design of low-bandgap organic semiconductors with strong absorption, favorable redox properties, and efficient charge transport is critical to advancing organic photovoltaics (OPVs). In this work, we report the synthesis of a series of naphthyl chalcone derivatives via Claisen-Schmidt condensation and their comprehensive evaluation using photophysical, electrochemical, and theoretical methods to assess their suitability for photovoltaic applications. UV- Vis absorption studies revealed strong solvent-dependent behavior, with maxima observed in the 380-460 nm range. The emission profiles, extending up to 560 nm, demonstrated pronounced solvatochromism, indicative of excited-state intramolecular charge transfer. Stokes shifts ranging from 80 to 157 nm suggested significant reorganization between ground and excited states, with larger shifts observed in molecules bearing strong electron-donating substituents. Electrochemical analysis using cyclic voltammetry showed quasi- reversible redox behavior and revealed HOMO-LUMO energy gaps in the range of 2.8-3.2 eV. The incorporation of electron-rich or electron- deficient substituents allowed for tuning of both optical and electrochemical properties. Notably, compounds with electron- donating aryl moieties such as dimethylamino exhibited higher fluorescence intensity. To support and rationalize the experimental findings, DFT and TD-DFT calculations were performed using the B3LYP/6-31G(d,p) level of theory. The computed absorption wavelengths were in good agreement with experimental data. Frontier molecular orbital analysis revealed strong donor-acceptor interactions across the π-system. Key computational descriptors, including dipole moments, density of states, transition density matrices, reorganization energies, and charge transfer integrals, were extracted to provide a deeper understanding of charge transport behavior and molecular stability. The combined photophysical, electrochemical, and computational results point toward favorable structure-property relationships in the scaffold. The large Stokes shifts, broad absorption, and effective intramolecular charge transfer support their potential as donor-acceptor systems in organic optoelectronics. Furthermore, their

tunable HOMO-LUMO levels and moderate fluorescence output make them attractive for integration into multilayered OPV devices, where controlled energy level alignment and charge mobility are essential for optimal power conversion efficiency. This study emphasizes combining experiments and computational modeling to design OPV materials. The investigated chalcones show promise, and future work aims to optimize them for better NIR absorption, stability, and device compatibility.

Keywords: Naphthyl chalcones, Photophysical properties, Electrochemical analysis, Lippert-Matga plots, Stokes shift analysis, DFT calculations, DOS analysis, Charge mobilities

CHE-1727: Amino-Functionalized Graphene Oxide Immobilized with Dansyl Chloride as a Sensitive Fluorescent Sensor for Mercury (II) Detection in Water

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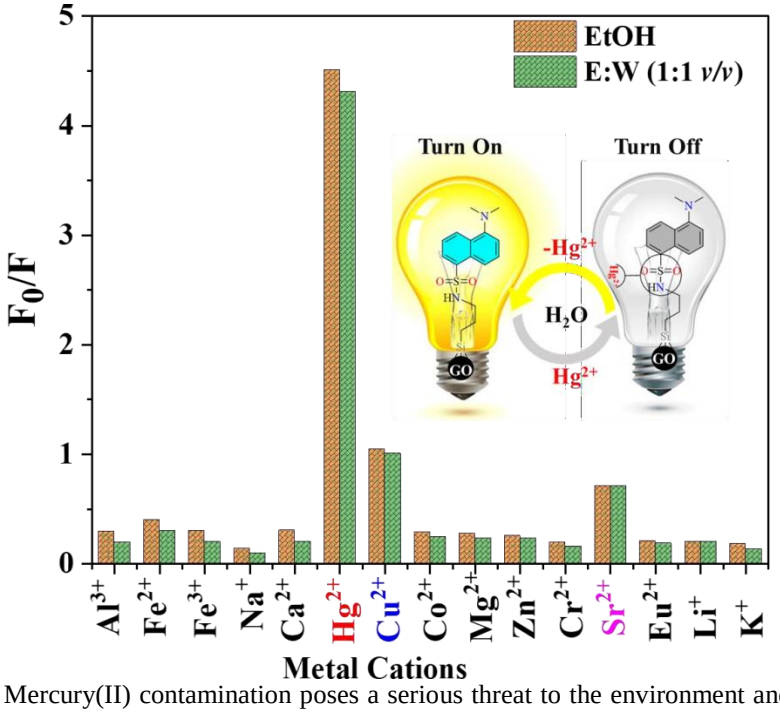
Graphical Abstract



Mercury(II) contamination poses a serious threat to the environment and public health due to its high toxicity and bioaccumulation. In this study, we present a rationally engineered fluorescent sensor, GO@NH@DNS, prepared by covalently immobilizing dansyl chloride (DNS-Cl) onto graphene oxide (GO) through (3-aminopropyl) triethoxysilane, thereby introducing a sulfonamide

(−SO_2NH−) recognition site for selective Hg^{2+} detection. The GO@NH@DNS sensor exhibited strong fluorescence at 528 nm in ethanol: water (E: W 1:1 *v/v*) and 512 nm in ethanol (EtOH), closely matching the TDDFT-simulated emission at 524 nm, which confirmed the successful grafting of the DNS moiety on GO. Characterization by fluorescence spectroscopy, FTIR, XRD, and SEM verified functionalization and immobilization, as indicated by the disappearance of the GO (001) reflection at 11.7° (2θ), the −SO_2NH− bands at 1406.19 cm^{-1}, and a notably roughened surface morphology. Upon exposure to Hg^{2+}, the fluorescence intensity was markedly quenched by 79% in EtOH and 68% in E:W 1:1 *v/v*, while other representative cations caused negligible interference, demonstrating the high selectivity of the system. Mechanistic insights from electron density mapping revealed a highly localized negative charge (−0.07379 $e^- Å^{-3}$) and notable softness (0.719 eV^{-1}) at the −SO_2NH− site, facilitating Hg^{2+} coordination and explaining the efficient quenching response. Benefiting from this rational design, GO@NH@DNS displayed rapid, linear, and sensitive responses to Hg^{2+} over the 0–35 µM range, with LODs of 0.60 µM in EtOH and 1.03 µM in E:W (1:1, *v/v*) and corresponding LOQs of 1.99 µM and 3.43 µM, achieving recoveries of 87.1–107.9% with RSDs below 3.6% in spiked samples. The sensor also exhibited excellent operational stability, with blank fluorescence RSDs of <0.4% in EtOH and ~1.0% in E:W (1:1, *v/v*), and no observable degradation over five months, establishing it as a robust, reusable, and highly selective solid-phase fluorescent platform for practical environmental Hg^{2+} monitoring.

Keywords: Graphene oxide, Dansyl chloride, Hg^{2+} sensing, Fluorescence quenching; Environmental samples

Cr (III) Nanoparticles synthesis using *Adiantum capillus-veneris* extract and its Antioxidant and Antidiabetic effects

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Biogenic synthesis of nanoparticles using plant extracts offer a sustainable and biocompatible alternative to conventional chemical methods, with promising applications in therapeutic development. In this study, chromium nanoparticles (CrNPs) were synthesized using *Adiantum capillus-veneris* extract, characterized through various instrumental techniques and evaluated for their antioxidant and antidiabetic potential *in vitro*. The optimal synthesis was achieved at a 4:9 ratio of plant extract to chromium salt. The synthesized CrNPs were crystalline in nature, irregular to round in shape, with sizes ranging from 58 to 90 nm, and thermally stable up to 280°C and exhibited strong absorbance peak in UV-Vis range at 420 nm. The EDX analysis confirmed the presence of chromium at ~0.6 keV. The CrNPs showed excellent antioxidant (DPPH, IC_{50} = 100 µg/mL; ABTS, IC_{50} = 125 µg/mL) and notable inhibition of carbohydrate-hydrolyzing enzymes; α-amylase (91.3% inhibition at 1000 µg/mL, IC_{50} = 127 µg/mL) and α-glucosidase (86.4% inhibition at 1000 µg/mL, IC_{50} = 140 µg/mL). CrNPs exhibited stronger biological potentials and outperformed both the aqueous and

methanolic extracts of *Adiantum capillus-veneris* plant, as well as chromium salt in employed antioxidant and antidiabetic tests. In conclusion, the study suggests the potential utilization of CrNPs as therapeutic agent in curing diabetes and related complications which needs to be further validated in experimental diabetic models. The observed synergistic effects of fabricated CrNPs were higher than parental extracts and metal salt.

Keywords: Antioxidant assay, Green synthesis, Metal nanoparticles, Phytochemical reduction, Plant-mediated synthesis

CHE-1845: Fabrication of Au-decorated V2O5 Based Sensor for Ultra Trace Level Detection of Ammonia in an Environment Resembling Human Exhaled Breath

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Ammonia stands out as a significant breath biomarker for kidney-related diseases. Here we present the fabrication of a gold (Au) decorated V_2O_5 based sensor designed for detecting ammonia at parts per billion (ppb) level. The V_2O_5 particles were synthesized by thermal decomposition of ammonium metavanadate (NH_4VO_3) instead of using tedious and expansive synthesis routes. The product of the thermal decomposition of NH_4VO_3 was characterized utilizing various analytical techniques. Then this product (V_2O_5) was used for gas sensing study as original and when decorated with gold. The V_2O_5 based sensor, decorated with gold (Au) for a duration of 10 seconds, exhibits favorable characteristics including a linear response range spanning 50 to 5000 ppb, heightened sensitivity, stability, and remarkable resistance to humidity within the range of 50% to 90% relative humidity (RH). Remarkably, the sensor demonstrates insensitivity towards higher concentrations of possible interfering liquid vapors. The sensor exhibits response and recovery times of 36 seconds and 300 seconds, respectively, in the presence of 1000 ppb ammonia and has the potential for accurately detecting and quantifying ammonia in an environment resembling human exhaled breath. The sensing device based on this material will be a valuable tool for clinical applications.

Keywords: Gas sensor, breath biomarkers, sensitivity, ammonia

CHE-1733: Next-Generation Antimicrobials: Silver–Nanodiamond Composites as a Breakthrough Against BAMR

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Bacterial antimicrobial resistance (BAMR) seems to pose the greatest threat to public health, food safety, and agriculture in this century. The development of novel, efficient antimicrobial agents to combat bacterial infections has become a global issue. Silver nanoparticles (Ag NPs) appeared as a feasible alternative to antibiotics. However, Ag NPs face cost, toxicity, and aggregation issues which limit their antibacterial activity. This work aims to stabilize Ag NPs with enhanced antimicrobial activity at comparatively lower Ag concentrations to prevent bacterial infections. For this purpose, the Ag core was covered with nanodiamonds (NDs). Ag-NDs composite have been synthesized by microplasma technique. TEM analysis confirmed the presence of both Ag and NDs in the Ag-NDs composite. Aparticle size (~19 nm) was reported for Ag-NDs at the highest concentration as compared to Ag NPs (~3 nm). The conduction band of the diamond acted as an extremely strong reducing agent for Ag NPs. The large surface area of NDs stabilized the Ag NPs. A redshift (~400 nm–406 nm) in UV–visible spectra of the Ag-NDs composite indicated the formation of bigger-sized Ag NPs after incorporating NDs. XRD and LIBS analysis verified the increase in intensity of Ag-NPs by increasing ND concentration. The presence of functional groups including OH, CH, and Ag/Ag2O was confirmed by FTIR. Bacterial inhibition growth appeared to be a dose-dependent process. The minimum inhibition concentration value of Ag-NDs composite at the highest NDs concentration against E. coli (~ 0.69 μg/ml) and S. aureus (~44 μg/ml). This is the first study to report the smallest MIC for E. coli (<1 μg/ml). Ag-ND composites emerged to be more efficient than Ag NPs and preferred to be used against BAMR. The enhanced antibacterial activity of the Ag-NDs composite makes it a potential candidate for antibiotics, food products, and pesticides.

Keywords: Bacterial antimicrobial resistance, silver, nanodiamonds, microplasma, micro-dilution broth method, minimum inhibition concentration

COMPUTER SCIENCE

An Enhance Diabetic Retinopathy Detection Model Using Quantum Machine Learning

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Diabetic Retinopathy (DR) is a leading cause of vision impairment worldwide, necessitating early detection and accurate classification for effective intervention. Traditional machine learning (ML) models have demonstrated significant success

in DR detection however, they face challenges related to computational efficiency, feature extraction, and interpretability. Quantum Machine Learning (QML) offers a promising alternative by leveraging quantum computing principles to enhance pattern recognition, optimize feature selection, and improve diagnostic accuracy. This paper explores the application of QML in DR diagnosis, focusing on quantum enhanced deep learning models and hybrid quantum classical frameworks. By utilizing algorithms such as Quantum Support Vector Machines (QSVMs) and Variational Quantum Circuits (VQCs), we investigate improvements in classification performance and computational speed. Experimental results suggest that QML models outperform classical counterparts in specific scenarios, demonstrating potential for early and more precise DR detection. This research highlights the role of Quantum Computing in medical imaging. It encourages further exploration of QMLbased solutions for ophthalmic diseases.

Keywords: Diabetic Retinopathy, Quantum Machine Learning, Quantum Support Vector Machine, Variational Quantum Circuit, Hybrid Quantum- Classical Model, Medical Imaging, Early Disease Detection.

CS-1917: AgriVision: AI-Driven Crop Disease Detection, Agri-Marketplace Integration, and Drone-Based Spray Services

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Agricultural productivity is significantly threatened by crop diseases, particularly in staple crops such as wheat and rice. This project introduces an AI-powered crop management system that integrates disease detection, decision support, and service delivery within a single platform. Using advanced image recognition, the system identifies common diseases in wheat and rice and provides tailored medicine recommendations. An integrated e-commerce module enables farmers to purchase the suggested medicines directly from multiple vendors, ensuring availability and competitive pricing. Beyond product accessibility, the platform connects farmers with agricultural experts through video consultations, offering personalized guidance for effective disease management. To further support field-level implementation, drone-based spraying services are incorporated, ensuring precise and efficient application of treatments. By unifying intelligent disease detection, digital commerce, expert consultation, and drone-enabled services, this system delivers a holistic solution that empowers farmers, minimizes crop losses, and promotes sustainable agricultural practices.

Keywords: Artificial Intelligence, Crop Disease Detection, Computer Vision, Machine Learning, Drone-Based Spray System, Precision Agriculture, Smart Farming

Diabetic Retinopathy Detection on the Early Onset

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In diabetics, diabetic retinopathy (DR) is the most common cause of vision loss. About 90% of the DR patients will be spared from visual loss if they are given proper care, which dictates to design a DR model for identifying the different severity levels to provide better care. This research contributes to an improved method for localizing, segmenting, and classifying various forms of DR lesions. The proposed designed consists of two modules, in module-I a novel localization model is proposed with the combination of pre-trained resnet-18 and YOLOv3.that is constructed with the selection of optimal layers to localize the retinal lesions. The localized images are segmented using semantic segmentation model, is developed by the combination of 16 selected CNN layers. The model is trained from the ground annotated masks and optimized learning parameters. The proposed model performance is evaluated on Grand-challenge IDRID dataset and improved results are reported. Later, in module-II deep features are derived from the pre-trained Efficientnet-b0 model and optimized using improved parameters of the Genetic algorithm (GA) for the classification of different types of DR lesions such as normal-DR (0), mild (1), moderate (2), and severe (3) on the Kaggle dataset. The proposed model achieved greater than 98% classification accuracy that is better as compared to already published work.

Keywords: Diabetic retinopathy, deep learning, ResNet-18,YOLOv3, semantic segmentation, EfficientNet-B0, genetic algorithm.

CS-1771: Parasite Malaria Detection and Classification Using Ensembled Neural Network

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Millions of people around the world are afflicted by malaria, a potentially lethal illness that frequently goes undiagnosed. Although microscopy is still frequently used for diagnosis, it greatly depends on professional interpretation. This paper suggests a deep learning-based categorization method that makes use of a Vision Transformer (ViT) to improve speed, accuracy, and scalability. We classified malaria- infected blood smear images from two datasets using a ViT-B/16 model pretrained on ImageNet. The images were divided into four classes: parasitized, uninfected, slides_with_positive_cells, and slides_with_ negative_cells. To ensure an equal distribution of classes, all photos were scaled to 224 x 224 pixels, normalized, and divided into training (70%), validation (15%), and test (15%) groups. Each image is split up into 16x16 patches by the ViT architecture, which then processes them using 12 transformer encoder layers. To generate predictions across the four categories, a softmax layer was applied after a bespoke linear head took the place of the original classifier. Training took place over 10 epochs using the AdamW optimizer, cross-entropy loss, and a batch size of 32. Following each

epoch, performance was monitored on the validation set, and all metrics were recorded for later examination. We introduced new output neurons to the classification head (for ring forms, trophozoites, etc.) while freezing the backbone to facilitate incremental learning while maintaining previously learned characteristics. Because only the new head was educated, the model was able to adjust without losing its existing information. Lastly, classification reports, confusion matrices, and one-vs-all ROC curves with AUC scores for each class were used to assess the model's performance on the test set

Keywords: Incremnetal learning, transformer, CNN, malaria

CS-1545: Large Language Models for Early Crop Disease Detection: Decoding RNA-Seq Linguistic Signals

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Agriculture is the backbone of Pakistan, a country of 255 million. Among several challenges of the traditional agricultural system, delayed disease detection is one of the major concerns causing low annual yield and crop losses. Pakistani farmers still depend on visual symptoms that emerge only after irreversible damage. To address these concerns, we propose a novel computational approach for early plant disease detection by treating RNA expression patterns as a computational linguistic problem. The BioLingual™ algorithm will apply advanced natural language processing (NLP) techniques to RNA-seq data to identify disease signatures up to three weeks before visible symptoms appear. Our pipeline will integrate already extracted RNA sequences from field samples, state-of-the-art analytics for pattern recognition, and the creation of Pakistan's first crop disease biomarker database. Initially targeting wheat crops, upon receiving sequencing/qPCR that are plant pathogen indicators, our bidirectional sequence modeling and self-attention approach extracts disease patterns from enriched RNA, outperforming traditional visual inspection for early disease detection, avoiding complex bioinformatics. The project's outcomes will strengthen national food security, enhance economic resilience, and position Pakistan as a leader in AI-enabled agricultural biotechnology.

Keywords: RNA expression analysis, computational linguistics, early disease detection, natural language processing, plant pathology, biomarker identification

CS-1792: Data-Efficient Transformers for Vision: Enhancing Accuracy under Resource Limitations

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In recent years, transformer-based architectures have revolutionized computer vision, achieving state-of-the-art results across diverse tasks. Nevertheless, conventional Vision Transformers (ViTs) demand massive datasets and substantial computational resources, which restricts their applicability in resource-constrained or data-scarce scenarios. To overcome this limitation, Data-Efficient Image Transformers (DEiTs) have been introduced, leveraging three key strategies: (i) knowledge distillation, where a compact student transformer benefits from the guidance of a powerful CNN teacher; (ii) optimized training protocols, including regularization and augmentation tailored for small data regimes; and (iii) efficient architectural modifications that reduce redundancy while preserving representational power. By integrating these mechanisms, DEiTs not only narrow the gap between transformers and CNNs under limited data conditions but also establish a scalable framework for future vision applications requiring both efficiency and accuracy.

Keywords: Vit, knowledge distillation, data augmentation, computer vision

CS-2030: Comparative Evaluation of Random Forest, XGBoost, Regression, and Classification Techniques in Forecasting Close Prices: A Case Study of Three PSX-Listed Companies

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Aim of this study is to evaluate and compare the performance of different Ml model such as Random Forest, XGBoost, Regression and Classification model. Three datasets of Pakistan stock Exchange companies (AI-Abid Silks Mill limited, AI-Abbas Sugar Mill limited, and AI-Ghazi Tractor limited) including feature (Date, Open, Close, High, Low and Volume) are used to compare the performance the ML models. Among the four models Random Forest model achieved 1.0792 RMSE and 59.7% accuracy for AI Abid silk mills and XGBoost achieved 1.098 RMSE and 63.55% accuracy, regression model achieved 4.186 RMSE and classification model achieved highest accuracy 76.55%.Random Forest model achieved 9.494 RMSE and 53.79% accuracy for AI Abbas Sugar mills and XGBoost achieved 9.474 RMSE and 55.72% accuracy, regression model achieved 44.04 RMSE and classification model achieved highest accuracy 71.46%. Random Forest model achieved 13.489 RMSE and 50.8% accuracy for AI Ghazi Tractor Limited mills and XGBoost achieved 13.585 RMSE and 52.6% accuracy, regression model achieved 12.841 RMSE and classification model achieved highest accuracy 71.7%. Among the four ML models, Random Forest and XGBoost models achieved the lowest root mean squared error for AI Abid

silk mills and for AI Abbas Sugar mills then AI Ghazi Tractor Limited data, RMSE value is used to evaluate the performance of Models, lowest RMSE show well working of ML models. Prediction of the model can help the sellers in identifying the best time to sell and enable brokers to develop informed trading strategies.

Keywords: Machine learning, stock market prediction, random forest, xgboost, regression, classification, pakistan stock exchange, rmse, accuracy, trading strategies

CS-1926: Visual Aid for Blind

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Visual impairment creates significant barriers to independence, making everyday tasks such as mobility, reading, and communication challenging. To overcome these limitations, this project presents Visual Aid for Blind, an AI and IoT-powered smart glasses system designed to provide real-time assistance to visually impaired individuals. The device, integrated with a mobile application, employs computer vision and deep learning for object detection, person recognition, text reading, and obstacle avoidance, with results conveyed through natural voice feedback. A built-in voice-command interface not only enables users to set map destinations and receive turn-by-turn navigation, but also allows them to operate their mobile phones entirely through voice, facilitating calls, messages, and app control without physical interaction. Engineered for affordability, portability, and user-friendliness, this solution enhances autonomy, safety, and confidence, while contributing to the development of next- generation assistive technologies that bridge the gap between disability and independence.

Keywords: Visual impairment, assistive technology, smart glasses, computer vision, deep learning, internet of things (iot), voice interaction

CS-1957: Enhanced Hospital Emergency Response with Post Quantum Cryptography.

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Emergency healthcare systems are essential for saving lives, but existing models often face delays, weak hospital–ambulance coordination, and insufficient data protection. With the advancement of quantum computing, classical cryptographic techniques such as RSA and ECC are becoming vulnerable, posing severe risks to sensitive patient information. The research gap lies in the lack of a unified and secure real-time emergency management platform that integrates intelligent hospital recommendations, ambulance booking, and quantum-resistant data protection. This project proposes a web-based emergency response system secured with Post-Quantum Cryptography (PQC). The system enables patients to input their symptoms in simple language, receive hospital suggestions based on

disease type and bed availability, and book ambulances with options such as AC/ICU facilities, price, and estimated arrival time. To ensure security, lattice-based PQC algorithms are applied to safeguard medical data during transmission. GPS integration allows real-time ambulance tracking, while APIs connect hospitals and ambulance services for live updates. The proposed platform focuses on three main aspects: (1) reducing delays in emergency handling through automation and real-time decision-making, (2) enhancing coordination between patients, hospitals, and ambulances, and (3) securing medical data against both current cyber threats and future quantum-based attacks. The system is designed for scalability, user-friendliness, and future readiness. The anticipated outcome is an emergency healthcare platform that improves response times, strengthens communication, and provides quantum- safe security for patient information. By bridging the gap between emergency coordination and advanced cryptography, this project offers a future-proof solution that can enhance public health infrastructure and save lives in critical situations.

Keywords: Emergency healthcare, post-quantum cryptography, hospital–ambulance coordination, lattice-based encryption, real-time tracking, quantum-safe security.

CS-2029: Enhancing Digital Inclusion through Accessible UI/UX Design

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Since technology is essential to communication, work, healthcare, and education in the twenty-first century, accessibility in digital platforms has become a critical need. Equal participation in the digital world is hampered by the fact that a sizable portion of websites and mobile applications are still inaccessible to people with disabilities. By investigating UI/UX accessibility enhancements through inclusive design practices, this study tackles the problem of digital exclusion. To find important accessibility gaps, the study starts by comparing well- known digital platforms to the Web Content Accessibility Guidelines (WCAG 2.1). Using Canva, Figma, and accessibility checkers, an accessible prototype is created based on the results, adding features like text-to-speech support, keyboard navigation, high contrast modes, and simplified layouts. To gauge efficacy, usability testing is subsequently carried out with a varied sample of participants. The findings show a significant improvement in task completion rates, productivity, and general user satisfaction, especially for users who are blind or have mobility issues. To guarantee inclusive digital transformation, the research also suggests a workable framework for incorporating accessibility into the UI/UX design process, providing developers and designers with guidelines they can follow.

Keywords: UI/UX accessibility, inclusive design, digital inclusion, web content accessibility guidelines, usability testing

CS-2031: 0000000-Smart Classification of Himalayan Pink Salt Using Machine Learning

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Himalayan Pink Salt, which originates in the Khewra Salt Mine of the Punjab region of Pakistan, has great cultural and economic significance, attracting over 250,000 visitors every year. It is globally marketed as a premium or spa product, very few studies have addressed the possibilities of the application of artificial intelligence to the assessment and grading of various grades of salt. Present salt processing techniques have been wanting in the ability to discern between grades of edible and non-edible salts. Non-dispensable salt can have a pink or crystalline sensory appearance; it may contain heavy metals, insoluble materials, or microbiological pollutions that do not become apparent by mere observation. We hypothesize that a supervised learning system that pairs CNN-based feature extraction with those of Random Forest and SVM classifiers can accurately predict the grades of Himalayan Pink Salt. However, lack of raw image datasets of salts sourced directly from mines limits the validity of the model, highlighting the importance of orderly data collection to prove the assumption above. The proposed system derives patterns of adulteration and picks out distinct features that allow precise classification of the edible and non-edible grades, thus providing pre- screening of the fields, quick sorting process, and minimized human inspections. The envisaged model is trained on adulteration profiles and constructs new features to enable the appropriate classification of non-edible and edible grades, thereby enabling preliminary assessment of fields, fast-tracking sorting operations, and reducing the reliance on manual analyses. By integrating cultural heritage with high- performance computational methods, the cross disciplinary research enhances the practice of the safety of trading, quality control, and demonstration of the promise of authentication systems of the objects of foods by artificial intelligence.

Keywords: Himalayan pink salt, artificial intelligence, machine learning, food safety, image classification, quality assurance, food authentication.

CS-2032: AI-Enabled Mobile Framework for Sustainable E-Waste Management in Developing Countries

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Electronic waste (e-waste) has become an inevitable outcome of technological growth. In developing regions, its informal handling without regulation or safety measures is escalating environmental and public health risks. Although current AI research in e-waste management focuses on automated sorting, recycling, and IoT systems for smart cities, the application of AI frameworks in underserved communities remains unexplored. Moreover, researchers are designing AI-based solutions, but they are often challenging to implement in resource-constrained settings, such as rural areas and small towns. This research study presents a mobile and AI-enabled e- waste management framework designed for developing

countries to monitor e-waste flows across the household-to-recycler value chain. It emphasizes the collaboration between local governments, scrap collectors, and formal recyclers to enable the development of a digitally traceable and sustainable e-waste ecosystem. This proposed approach aims to reduce illegal dumping and hazardous recycling practices and bring transparency in e-waste flows. It provides governments and industries with data-driven insights to effectively design recycling policies. By combining mobile platforms with AI-driven traceability, the study introduces an innovative model for e-waste governance that can be replicated globally.

Keywords: E-waste management, sustainable computing, AI for sustainability, mobile platforms, traceability

CS-1833: Contrastive Learning for Hybrid Fault and Intrusion Detection in UAV Cyber-Physical Systems

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Unmanned Aerial Vehicles (UAVs) are becoming an integral part of cyber-physical systems (CPS), but their increasing reliance on interconnected communication makes them highly vulnerable to both system faults and cyber intrusions. Previous research has largely focused on either fault detection or intrusion detection in isolation, leaving a gap for an integrated framework capable of handling both threats simultaneously while distinguishing normal UAV operations. In this paper, we introduce Secure-AI-FDD, a hybrid deep learning framework that unifies fault detection, intrusion detection, and normal operation classification. The novelty of our approach lies in leveraging contrastive learning using TabNet as a backbone to structure UAV data into three super-classes: fault, intrusion, and normal operation. Within each super-class, we apply a nested pairing technique to generate subclass pairs (e.g., specific intrusion types grouped under intrusion, fault categories under fault, etc.), enabling the model to learn fine- grained distinctions. To enable experimentation, we curated a synthetic UAV dataset, carefully formatted to support contrastive training. Experimental evaluation demonstrates that Secure-AI-FDD achieves an overall accuracy of 78%, effectively detecting and classifying UAV states across faults, intrusions, and normal operational subclasses. This work contributes a significant advancement toward building robust, AI- driven, hybrid anomaly detection systems for UAV-CPS environments, enhancing their reliability, resilience, and trustworthiness.

Keywords: UAV security, cyber-physical systems, fault detection, intrusion detection, contrastive learning

CS-1834: Hierarchical UAV Behavior Classification using Deep Tabular Learning with TabNet

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Unmanned Aerial Vehicles (UAVs) are increasingly employed in diverse applications—from surveillance and inspection to delivery—generating vast amounts of structured telemetry data. To enable accurate, interpretable mission profiling, we propose a dual- stage TabNet framework trained entirely on synthetic UAV telemetry. First, we simulate 12,000 missions (Surveillance, Delivery, and Inspection) in Microsoft AirSim under varied environmental conditions, logging 10 Hz multivariate data (GPS, velocities, battery status, event flags). Segments of 10–15 s are aggregated into 20 statistical and spectral features. Stage I classifies each segment into one of three super-classes, achieving 80.36% accuracy, while Stage II refines predictions into five sub-classes, achieving 76.04% accuracy. Both TabNet models leverage entmax attention masks for per-instance feature selection, enabling insight into the most salient telemetry variables. We compare our work to ten related studies on tabular deep learning, synthetic data generation, and hierarchical classification, demonstrating that our approach uniquely combines hierarchical modeling, simulation-driven dataset creation, and interpretability. Our open-source code and synthetic dataset are publicly available. These results validate the viability of simulation-first, interpretable deep tabular learning for UAV mission analysis and pave the way for real- world deployment via sim-to-real adaptation.

Keywords: UAV security, cyber-physical systems, fault detection, intrusion detection, tabnet

CS-1842: Advanced Versatile Humanoid Robot for Intelligent Human Interaction and Safety Automation

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This project presents the development of an Advanced Versatile Humanoid Robot (AVHR) designed to replicate and extend human capabilities for safety, monitoring, and interaction purposes. Originally conceptualized during the COVID-19 pandemic, the robot was built to minimize human exposure and reduce health risks by integrating functionalities such as face detection, face mask detection, temperature monitoring, vaccination status verification, and automatic access control through smart door activation. As technology evolved, the robot was upgraded with more advanced AI-driven capabilities including object tracking, human behavior mimicking, and natural language-based human-like conversations. The AVHR is a fully autonomous humanoid platform that combines computer vision, AI, and robotics to serve in high-risk environments, corporate facilities, public institutions, and potentially healthcare and educational sectors. The long-term vision is to create a machine that not only mimics humans but also assists and outperforms them in specific operational domains.

Keywords: Humanoid robotics, artificial intelligence (AI), Computer Vision, Human–Robot Interaction (HRI), autonomous systems.

CS-1843: Hierarchical UAV Behavior Classification using Deep Tabular Learning with TabNet

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Unmanned Aerial Vehicles (UAVs) are increasingly employed in diverse applications—from surveillance and inspection to delivery—generating vast amounts of structured telemetry data. To enable accurate, interpretable mission profiling, we propose a dual- stage TabNet framework trained entirely on synthetic UAV telemetry. First, we simulate 12,000 missions (Surveillance, Delivery, and Inspection) in Microsoft AirSim under varied environmental conditions, logging 10 Hz multivariate data (GPS, velocities, battery status, event flags). Segments of 10–15 s are aggregated into 20 statistical and spectral features. Stage I classifies each segment into one of three super-classes, achieving 80.36% accuracy, while Stage II refines predictions into five sub-classes, achieving 76.04% accuracy. Both TabNet models leverage entmax attention masks for per-instance feature selection, enabling insight into the most salient telemetry variables. We compare our work to ten related studies on tabular deep learning, synthetic data generation, and hierarchical classification, demonstrating that our approach uniquely combines hierarchical modeling, simulation-driven dataset creation, and interpretability. Our open-source code and synthetic dataset are publicly available. These results validate the viability of simulation-first, interpretable deep tabular learning for UAV mission analysis and pave the way for real- world deployment via sim-to-real adaptation.

Keywords: UAV security, cyber-physical systems, fault detection, intrusion detection, tabnet

CS-1844: Harnessing Quantum Convolutional Neural Networks for Detection and Classification of Astrophysical Objects

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Telescopes generate an enormous amount of high- dimensional, complex astrophysical data, posing substantial challenges for classical machine learning methods regarding efficiency, scalability, and accuracy. Quantum Machine Learning (QML) has become a pioneering paradigm that utilizes the concepts of quantum computation and quantum information to improve data representation as well as pattern recognition abilities beyond the limitations of traditional methods. In this study, we examine the application of QML models like Variation AL Quantum Circuits and Quantum Convolutional Neural Networks (QCNNs) for the classification of astronomical bodies such as stars and galaxies. By encoding astronomical attributes derived from spectroscopic and photometric data into quantum states, these QCNNs leverage superposition and entanglement to capture complex correlations in astronomical datasets. Our work demonstrates how QML can enhance classification accuracy, reduce model complexity, and offer computational advantages when compared to classical deep learning methods. Our obtained results suggest that quantum-enriched classification frameworks

could play a pivotal role in the advanced large-scale astronomical surveys, bridging the gap between astrophysics, artificial intelligence, and quantum computing.

Keywords: Quantum, qubits, convolutional, objects

CS-1882: Skin Cancer Classification Using Transformer with Incremental Learning

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Skin cancer is one of the most common forms of cancer worldwide, and its early detection is essential for effective treatment and improved survival rates. Traditional deep learning models often require retraining from scratch when new data becomes available, which increases computational cost and risks catastrophic forgetting. To address this challenge, we propose a transformer-based framework integrated with incremental learning for skin cancer classification. The transformer architecture captures both local and global contextual features from dermoscopic images, while incremental learning allows the model to adapt continuously to newly available datasets without losing previously acquired knowledge. Experimental results demonstrate that the proposed approach achieves competitive accuracy and robustness compared to conventional deep learning models, while maintaining efficiency in handling evolving datasets. This method shows potential for real-world deployment in clinical decision-support systems where continuous learning from diverse and growing datasets is critical.

Keywords: Skin cancer, transformer, incremental learning, deep learning, classification, medical imaging

Anomaly Detection in Surveillance Videos using Mobile Friendly Vision Transformer Neural Network

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Detection of anomaly in surveillance videos is a critical task for better public safety. This study used a Deep Learning (DL) approach to classify and detect anomalous events in real-time video feeds. MobileViT model was used for classification purposes which is the combination of the CNN and Transformer model showed 93% accuracy for 7 classes and 98% accuracy for 6 classes on the UCF-Crime dataset. The UNI-Crime dataset was solving a binary classification problem and showed 100% accuracy. These results are much higher than state-of- the-art work. After classification, the classified images are passed to the YOLO-v11 model and detect the part of anomalous activity on the selected Hyperparameters. The YOLO-v11 model was applied to the classification model output for accurate localization of anomalies. The result shows that the proposed models are effective in identifying anomalous events. This study has opened new opportunities for developing real-world applications that improve surveillance systems in various

environments. The promising outcomes of this research provide a robust basis for future work in anomaly detection, with the potential to enhance both security and effectiveness in video-based surveillance.

Keywords: YOLO-v11, localization, transformer,anomalous, classification

CS-2024: Eye-Blink Assistive Communication System for Motor-Impaired Users

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Individuals with severe motor disabilities (such as advanced ALS or high-level spinal injury) often have no limb control and only eye movements remain voluntary[1]. To restore communication, we propose a novel assistive interface that converts intentional eye blinks into text or speech. Our design draws on existing eye-based methods (for example, Stephen Hawking's ACAT system[2] and smartphone camera–based tracking apps[3]) but uses only low-cost, readily available hardware. A non-invasive sensor (electrodes or a webcam) captures eyelid closures, which a microcontroller digitizes into input signals. For example, one can map blink sequences to Morse-like codes – an approach used by the Synaspeak EEG project, which achieved full text entry with roughly $100 of hardware[4]. In our system, the microcontroller runs a blink-detection algorithm: it samples the electrooculography (EOG) waveform and applies a threshold to identify blinks, yielding response times on the order of tens of milliseconds[5]. Each detected blink then triggers a software action, such as advancing the highlighted letter or option on screen. Unlike static scanning keyboards, our interface presents choices in a simple interactive narrative or game format to keep users engaged. For instance, the user might navigate a branching story or predictive text grid: each blink selects the highlighted choice, gradually building a sentence. Because we rely on eye-electrode signals rather than expensive infrared or camera trackers, the hardware is minimal and affordable. Prior experiments show that even inexpensive EOG setups can attain blink-detection accuracies around 95%[6]. By combining proven blink-detection hardware (such as Arduino-based EOG circuits[7]) with a user-friendly interface, our system enables motor- impaired users to "speak" via eye blinks. This low-cost, flexible design could empower locked-in patients to communicate their thoughts in real time.

Keywords: Himalayan pink salt, artificial intelligence, machine learning, food safety, image classification, quality assurance, food authentication.

CS-2027: AI-Enabled Micro-Expression Analysis for Early Identification of Domestic Violence in Healthcare Contexts

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Domestic violence impacts millions of individuals worldwide, but remains highly underreported due to fear, shame, and coercive control. To a degree, healthcare settings are intervention points for domestic violence, or can be critical detection points. At present, existing methods for domestic violence detection are based upon self-disclosure by patients, and overt signs of wounds/injuries, which does not capture many instances of control, emotional, and subtle/early-stage physical abuse. This research presents a nascent artificial intelligence framework to detect potential domestic violence victims by analyzing micro-expressions, vocal stress patterns, and inconsistencies in behavior during everyday healthcare interactions. To achieve this goal, the study develops a multimodal AI system that combines computer vision for analyzing micro-expressions, natural language processing for vocal stress patterns, and generally-federated learning architectures to avoid disrupting patient care and ensure privacy. The study includes ethically-sourced training data using sustained consent from the participants. The training also follows a differential privacy approach to minimize likelihood of reidentifying an individual participant residing in a multitude of countervailing confounding factors (e.g. cultural, social, economic status, race, sexual orientation, etc.), which can delineate patterns within socio- demographic groups. The anticipated outputs of this endeavor are a culture-sensitive tool capable of identifying cases for trained professionals to investigate with care. The complete system aspires to be 85% accurate with at-risk individuals and zero inaccurate identifications based on human-in-the-loop manipulations. Implementation will include working with healthcare organizations, domestic violence organizations, and an ethics board to ensure responsible implementation. We are addressing a significant gap for AI and social good by allowing healthcare professionals the use of a non- invasive tool to identify vulnerable populations. Using the anonymity preserving protocol allows patients to maintain their confidentiality while we potentially protect them with early intervention and connected resources to assistance.

Keywords: Domestic violence detection, micro-expression analysis, federated learning, healthcare AI, privacy-preserving machine learning, social impact technology, behavioral pattern recognition.

CS-2039: AI-Enhanced Key logger in MASM x 86 Assembly for Sensitive Data Detection

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In today's digital world, across communication platforms, authentication systems, and digital services, a large volume of data is typed. Traditional keyloggers, that do not filter and capture every keystroke, produce an excessive amount of irrelevant data that makes it nearly impossible to identify sensitive information. To tackle this problem, this study presents a progressive approach by integrating artificial intelligence into a MASM x86 low-level assembly keylogger. The suggested system facilitates precise differentiation between ordinary text and sensitive data such as usernames and passwords.The system achieves this through the analysis of keystroke sequences and pinpointing outliers in character structures. While standard text generally recognizes patterns composed of alphabetic or numeric characters, sensitive data in most cases exhibits irregular arrangements of alphabetic, numeric, and special symbols. By exploiting these distinctive features, the AI models minimize redundant logging, emphasize potentially critical keystrokes, and enhance the overall efficiency of capturing. The results highlight the feasibility of merging AI-driven classification with low-level monitoring tools. Still, the system has some limitations, depending on the quality of the training dataset, and the misunderstanding of weak or short passwords. Moreover, ethical and legal consequences limit the practical deployment of these systems to controlled research environments. Regardless of these restrictions, this research opens the path for more advanced, selective, and efficient keystroke analysis methodologies.

Keywords: Keylogger, MASM x86 assembly, artificial intelligence, keystroke analysis, sensitive data detection

CS-1970: Quantum Inspired Distracted Driving Behaviour Detection

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Distracted driving is a major cause of road accidents around the world. To reduce such incidents, we need smarter and faster systems that can detect distractions in real time. This study presents a hybrid model that combines quantum computing with deep learning to detect distracted driving. The proposed quantum inspired deep learning model uses the power of quantum computing to process high-dimensional data more efficiently. It also takes advantage of classical deep learning methods for strong pattern recognition. First, images are preprocessed by resizing, augmenting, and normalizing them. Then, they are converted into 212-dimensional vectors for quantum processing. The quantum part of the model uses 12 qubits and applies 10 layers of entangled quantum gates. After processing, it uses Pauli-Z gates to extract important features. These features are then passed to a SoftMax classifier, which predicts the driver's behavior. Two popular datasets,

State Farm Distracted Driver Detection and AUC Distracted Driver, were used for training and testing of the proposed model. Both datasets contain 10 types of driving behaviors, such as texting, talking, or eating while driving. The proposed model achieved a high accuracy of 99.11%, performing better than standard CNN models.

Keywords: Driver attention monitoring, quantum inspired deep learning framework, distracted driving behavior

INFORMATION TECHNOLOGY

IT-1650: VocaSync – Real-Time AI Voice Translation

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VocaSync is an AI-powered real-time speech-to-speech translation system that removes language barriers by instantly and synchronously converting spoken words from one language to another while preserving the speaker's tone, emotion, and rhythm. As one person speaks, the other person hears the translated version in their own language at the same time, creating a seamless, parallel conversation experience. Unlike text-based or delayed translation tools, VocaSync enables natural, expressive, and hands-free communication without typing. Using advanced AI, NLP, and voice cloning technologies, it ensures accurate, context-aware, and emotionally aligned translations. Compact and user-friendly, it can be used in global communication, education, travel, and entertainment—redefining how people connect by making every voice instantly understood across languages and cultures.

Keywords: AI, Speech-to-Speech Translation, Real-Time Communication, Voice Cloning, NLP, Multilingual Interaction

IT-1651: A Smart Traffic Monitoring System for Urban Pakistan

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This project presents a Smart Traffic Monitoring System tailored for urban Pakistan, combining adaptive signal control and enhanced pedestrian safety. The system uses locally available sensor modules (e.g. PIR motion sensors, IR/ultrasonic obstacle sensors, inductive loop detectors) integrated with embedded controllers (such as Arduino or Raspberry Pi) to monitor vehicle flow and queue lengths in real time. Object detection algorithms (e.g. lightweight CNNs like EfficientDet-Lite or Tiny-DSOD) are deployed on edge hardware for recognizing pedestrians—especially children or elderly—waiting to cross. When a crossing is requested via push button or detection, all vehicular signals switch to a special blue-light mode, halting traffic to allow safe passage. Communication among sensors, controllers, and a central dashboard is achieved using WiFi or wired links; periodic local data logging and minimal cloud involvement ensures

resilience. Evaluations focus on vehicle wait times, pedestrian crossing safety and duration, system latency, and reliability under varying traffic volumes and weather conditions. The proposed system is feasible in Pakistani urban settings, aiming to improve responsiveness, inclusivity, and efficiency of traffic infrastructure.

Keywords: Object detection algorithms, PIR motion sensors, Smart Traffic Monitoring System, lightweight CNNs, Traffic infrastructure, IoT, Efficient Det-Lite or Tiny-DSOD

IT-1715: An AI-Based Framework for Enhancing Mobile and Application Security

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In today's digital world, mobile phones have become the main source of personal and professional communication. However, with the rapid increase in mobile applications and online connectivity, security and privacy risks are growing. Users often install apps without checking permissions, leading to data theft, malware infections, and privacy breaches. This project, An AI-based framework for enhancing Mobile & Application Security Solution, aims to develop an intelligent mobile security system that provides real-time protection against potential threats. The system will scan all installed applications, detect unusual behaviors, and alert users about unsafe permissions or malicious activity. It will also monitor network security, identify insecure Wi-Fi connections, and offer a privacy dashboard showing the overall security status of the device. The proposed solution will use AI- based behavior analysis, encryption, and permission auditing to enhance mobile and application security. Through its simple interface and smart protection features, an AI-based framework will empower users to take full control of their device privacy and ensure a safer digital experience.

Keywords: Mobile Security, Application Security, Cyber Security, Data Privacy, AI Threat Detection, Malware Protection, Network Safety

IT-1737: SWARM-AI-Based Nano Défense System for Future Combat and Infrastructure Protection

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In an era of increasing aerial and electronic threats, conventional defense systems face limitations of cost, adaptability, and resilience. This research introduces a conceptual framework for a Swarm-AI Nano Defense Dome, an intelligent, self-organizing protective network that operates through trillions of nano-scale agents forming an adaptive shield around critical infrastructure. Inspired by natural swarm behavior, these nano-agents cooperate using swarm algorithms and real-time AI decision-making to detect and neutralize potential aerial or cyber threats before impact. The proposed system emphasizes distributed intelligence, adaptive

coverage, and multi-layer communication security, potentially revolutionizing the defense landscape. While this study focuses on the conceptual and algorithmic foundations rather than physical implementation, it outlines how such technology could strengthen both military and civilian protection infrastructures. Ethical safeguards, cybersecurity protocols, and feasibility considerations are also discussed to ensure responsible innovation. This research aims to ignite discussion and collaboration toward developing sustainable, intelligent, and globally cooperative defense technologies.
Keywords: Swarm AI, Nano Defense System, Autonomous Security, Artificial Intelligence, Cyber Defense, Adaptive Shield, Smart Infrastructure Protection, Future Combat, Nano Robotics

IT-1777: Cybersecurity Threats in Mobile Apps: Challenges and Potential Solutions

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Mobile apps are vulnerable to various cybersecurity threats, including data breaches, malware, and unauthorized access. These threats compromise sensitive user data and undermine trust in mobile technology. Key challenges include insecure data storage, inadequate encryption, and poor authentication mechanisms. Potential solutions involve implementing robust security protocols, such as secure coding practices, encryption, and multi-factor authentication, to safeguard mobile apps and protect user data. Regular security audits and penetration testing can help identify vulnerabilities. Implementing a secure software development lifecycle (SDLC) can reduce risks. User education and awareness programs can prevent phishing and other social engineering attacks. Mobile app developers must prioritize security to build trust with users and protect sensitive data. By doing so, they can ensure the integrity and confidentiality of user information.
Keywords: Cybersecurity, Software Development Lifecycle (SDLC), Vulnerable, Artificial Intelligence.

IT-1803: Challenges of Adoptees/Care-Experienced Persons in a Pakistani Islamic Socio-Legal Context

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Adoption remains a complex and often stigmatized issue in Pakistan, where religious and socio-legal frameworks shape public perception and policies. For adult adoptees and care-experienced individuals, challenges such as identity formation are particularly pronounced with implications for mental health and social adjustment. This research with several studies aims to explore the identity concerns, mental health and wellbeing of adult adoptees in Pakistani Islamic

socio-legal context. Ethical approval would be obtained. Using purposive and snowball sampling, and interdisciplinary methodological approaches (details to be developed further), we would recruit adult adoptees and adoptive parents aged 18 years or above from universities, communities, adoption NGOs, adoption networks, and networks from orphanages to examine identity concerns, mental health and wellbeing issues of adoptees. This research has implications for the development of linkages and an adoptee support group with adoptee/adoptive parent participants to form a collaborative consultation focus group to build consensus on resolving identity and wellbeing issues and creating awareness to counter adoption stigma and establish a resource center with adoptee-specific competence for this purpose. In the long term, there are implications for the development of adoptee inclusive terminology, adoptees' wellbeing and their recognition as a marginalised and an ignored section of the Pakistani society. Findings are expected to raise awareness of adoptees' unique access needs and societal inclusion, contribute to evidence based results for adoption policies, legal adoption frameworks, stigma reduction, tools for adoptive parents, and support of mental health needs of adoptees in Pakistan.

Keywords: Adoptees, Pakistan, Islamic, Legal, Social

IT-1835: Enhanced Hospital Emergency Response with Post Quantum Cryptography

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Emergency healthcare systems are essential for saving lives, but existing models often face delays, weak hospital–ambulance coordination, and insufficient data protection. With the advancement of quantum computing, classical cryptographic techniques such as RSA and ECC are becoming vulnerable, posing severe risks to sensitive patient information. The research gap lies in the lack of a unified and secure real-time emergency management platform that integrates intelligent hospital recommendations, ambulance booking, and quantum-resistant data protection. This project proposes a web-based emergency response system secured with Post-Quantum Cryptography (PQC). The system enables patients to input their symptoms in simple language, receive hospital suggestions based on disease type and bed availability, and book ambulances with options such as AC/ICU facilities, price, and estimated arrival time. To ensure security, lattice-based PQC algorithms are applied to safeguard medical data during transmission. GPS integration allows real-time ambulance tracking, while APIs connect hospitals and ambulance services for live updates. The proposed platform focuses on three main aspects: (1) reducing delays in emergency handling through automation and real-time decision-making, (2) enhancing coordination between patients, hospitals, and ambulances, and (3) securing medical data against both current cyber threats and future quantum-based attacks. The system is designed for scalability, user-friendliness, and future readiness. The anticipated outcome is an emergency healthcare platform that improves response times, strengthens

communication, and provides quantum- safe security for patient information. By bridging the gap between emergency coordination and advanced cryptography, this project offers a future-proof solution that can enhance public health infrastructure and save lives in critical situations.

Keywords: Emergency healthcare, Post-Quantum Cryptography, Hospital–ambulance coordination, Lattice-based encryption, Real-time tracking, Quantum-safe security.

IT-1846: Machine Learning-Optimized synthesis of bismuth and cerium oxide Nanocomposites for Enhanced Photocatalytic Application

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It is a great challenge to acquire novel Bi 2 WO 6 /MIL- 53(Al) (BWO/MIL) nanocomposites with excellent catalytic activity by the trial-and-error method in the vast untapped synthetic space. The degradation rate of Rhodamine B dye (DR RhB) can be used as the main parameter to evaluate the catalytic activity of BWO/MIL nanocomposites. In this work, a machine learning- based nano-photocatalyst module was developed to speed up the design of BWO/MIL with desirable performance. Firstly, the DR RhB dataset was constructed, and four key features related to the synthetic conditions of BWO/MIL were filtered by the forward feature selection method based on support vector regression (SVR). Secondly, the SVR model with radical basis function for predicting the DR RhB of BWO/MIL was established with the key features and optimal hyperparameters. The correlation coefficients (R) between predicted and experimental DR RhB were 0.823 and 0.884 for leave-one-out cross-validation (LOOCV) and the external test, respectively. Thirdly, potential BWO/MIL nanocomposites with higher DR RhB were discovered by inverse projection, the prediction model, and virtual screening from the synthesis space. Meanwhile, an online web service (http://1.14.49.110/online_predict/BWO2) was built to share the model for predicting the DR RhB of BWO/MIL. Moreover, sensitivity analysis was brought into boosting the model' s explainability and illustrating how the DR RhB of BWO/MIL changes over the four key features, respectively. The method mentioned here can provide valuable clues to develop new nanocomposites with the desired properties and accelerate the design of nano-photocatalysts.

Keywords: leave-one-out cross-validation, Rhodamine B dye, nano-photocatalysts

IT-2073: IOT Based Smart Home System

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Smart home devices are currently increasing in our daily lives, due to the convenience that users can easily access IoT devices to monitor and control their homes using smartphones and internet. Energy and water conservation are crucial, especially for household appliances, given the growing pressure to protect the environment for the sake of our planet. Since refrigerators, air conditioners, washing machines, and desert air coolers are necessary energy and water users, this study will focus on investigating sustainable innovation in these household appliances. The goal of the paper will present better systems that ensure better resource utilization and efficiency in addition to user comfort by utilizing IoT integration, premium sensors, and machine learning algorithms. The incorporation of AI-driven predictive maintenance further enhances reliability and reduces waste by alerting users to potential failures before they occur. Additionally, the development of user-friendly mobile and web interfaces empowers consumers to monitor and manage their appliances in real time, fostering energy-conscious behavior. Although smart appliances may have a higher initial cost, long-term savings on utility bills make them a financially viable investment. highlights the transformative potential of smart home appliances, reinforcing the role of technology in promoting sustainable living. Future advancements will only enhance their efficiency, shaping a more resource-conscious and eco-friendly future.

Keywords: Home Automation, Internet of Things (IoT), Machine Learning, Energy Efficiency, Smart Buildings

IT-1859: Smart Rice Crop Disease Detection and Nutrients Monitoring System

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Agriculture, as the foundation of human nutrition and economic stability, requires innovative solutions to address challenges such as climate change, resource limitations, and crop diseases. Rice, a staple food for over half of the global population, demands alert monitoring to ensure healthy growth and optimal yields. Traditional manual crop inspections in Pakistan are labor-intensive, time-consuming, and often reactive rather than proactive, leading to crop losses and inefficient resource use. This project introduces an integrated system that powers modern technology to enhance rice crop management. The system captures images of rice plants through mobile devices or cameras, which are then analyzed using machine learning models to detect common diseases like leaf blast, bacterial blight, and brown spot. Concurrently, IoT sensors deployed in the fields continuously monitor critical environmental parameters such as soil nutrients (NPK), moisture, pH, temperature, and humidity, providing real-time data. By

producing disease detection results with sensor data, the system offers actionable insights and recommendations for preventive measures, enabling farmers to respond promptly and effectively. This comprehensive approach facilitates early disease identification, resource optimization, and improved crop health, finally increasing rice productivity. The proposed solution aims to empower farmers with accessible, data-driven tools to promote manageable agriculture and food security, especially in regions weak to climatic and resource-related stresses.

Keywords: Crop disease detection, IoT sensors, rice farming, environmental monitoring, sustainable agriculture

IT-1878: SafeBand: An Affordable IoT-Based Smart Safety Bracelet for Women's Protection

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Women's safety remains a major concern in Pakistan, especially for those working night shifts, traveling alone, or living in hostels. SafeBand is an affordable, AI-enabled IoT-based wearable device designed to provide instant emergency assistance through a smart bracelet. The system allows a woman to discreetly send alerts by pressing a hidden button or speaking a secret voice command. Powered by an ESP32 microcontroller integrated with GSM (SIM800L) and GPS (NEO-6M) modules, the device automatically sends the user's live location to registered guardians via SMS, initiates an emergency call, activates a loud buzzer, and starts background audio recording for evidence. A companion Android application enables guardians to receive alerts, track the user's location, and access recorded data in real time. SafeBand focuses on reliability, affordability, and privacy while operating effectively even in areas with weak internet connectivity. Its compact design and long battery life make it suitable for everyday use. Additionally, an AI module analyzes stored alert data to identify locations and time periods that are frequently unsafe. These insights can help predict and highlight potential danger zones, improving public awareness and safety planning. This project offers a practical, intelligent, and low-cost technological solution aimed at enhancing women's safety, confidence, and mobility in daily life.

Keywords: Women Safety, IoT, GSM, GPS Tracking, Wearable Device, Emergency Alert

IT-1909: An AI-Powered System for Automated Duty Scheduling

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Manual duty scheduling in organizations is a complex, time- consuming process prone to human error, scheduling conflicts, and inequitable workload distribution. This project presents the design and implementation of an intelligent system to automate and optimize duty roster generation. The system employs a dual-stage approach. Initially, a rule-based algorithm generates a foundational timetable by

processing predefined constraints, such as staff availability, role requirements, and fixed holidays. This baseline schedule is then enhanced by a predictive AI model. Leveraging machine learning, the AI component analyzes historical data and employee patterns to predict and assign duties to the most suitable personnel, aiming to balance workloads and improve operational efficiency. Key functionalities include a fully automated notification system that informs staff of their assigned duties via email or SMS, and the generation of comprehensive analytical reports for management. The proposed system seeks to significantly reduce administrative overhead, minimize scheduling errors, and ensure a fair, transparent, and efficient workforce management solution.

Keywords: AI-Powered System, IoT, Automated Duty Scheduling, time-consuming process

IT-1910: IoT-Based Vehicle Monitoring and Accident Alert System

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Road accidents are a major global issue, resulting in the loss of lives, injuries, and significant economic damage. Quick and accurate emergency response is vital to reduce these effects, but existing systems often fail to deliver timely alerts. This project, IoT-Based Vehicle Monitoring and Accident Alert System, presents a smart and efficient solution for detecting accidents and sending immediate notifications with precise GPS location. The system uses an accelerometer to sense sudden motion changes, a GPS module for real- time tracking, and a GSM module to communicate with emergency contacts. All components are controlled by an Arduino microcontroller. To avoid false alerts, a buzzer and an "I AM OK" button are included, allowing the driver or passengers to cancel false notifications within a set time. The system operates automatically, even if the driver is unable to respond, ensuring quick and reliable emergency alerts. By integrating IoT technology, this cost-effective and scalable system improves road safety, shortens emergency response times, and helps reduce accident-related injuries and fatalities.

Keywords: CNNs, IoT, Smart Traffic Monitoring System, PIR motion sensors, Efficient Det-Lite or Tiny-DSOD

IT-1969: Smart Vision: An IoT-Based Smart Stick for Blind Persons

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Smart Vision is an innovative IoT-based smart stick developed to empower visually impaired individuals with enhanced safety, mobility, and independence. Equipped with ultrasonic sensors, it intelligently detects obstacles and alerts the user through vibrations and sound. A Bluetooth-enabled "Find My Stick" feature helps locate the stick easily, while an integrated SOS button instantly sends emergency messages for timely assistance. The companion mobile app provides real-time obstacle distance, device status, and remote-control functions.

Advanced features such as AI voice feedback, distance- based voice alerts, and automatic fall detection further improve situational awareness and user protection, making Smart Vision a comprehensive and reliable assistive solution.
Keywords: Smart Vision, Bluetooth-enabled, IoT-Based Smart Stick, SOS button

IT-1980: MindTrack: An AI-Based Mental Wellness Companion

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Mental health refers to a person's emotional, psychological, and social well-being, affecting how they think, feel, and behave in everyday life. Taking steps such as practicing mindfulness, maintaining healthy relationships, managing stress, and seeking professional help when needed can greatly improve mental health. MindTrack is an AI- based mental wellness companion designed to detect early signs of stress, anxiety, and burnout through behavioral analytics, voice tone, and text sentiment analysis. Using this data, it provides personalized relaxation exercises, mindfulness activities, and journaling prompts, while its secure AI chatbot offers empathetic conversational support and connects users with certified therapists when necessary. By integrating artificial intelligence, psychology, and mobile health technology, MindTrack makes mental wellness more accessible, private, and data-driven, encouraging users to take proactive steps toward emotional balance and resilience.
Keywords: Mental health, emotional balance, AI-Based Mental Wellness Companion, integrating artificial intelligence

IT-2017: Spatio-Temporal Modeling of Sign Language Using YOLOv11 Detection and LSTM Sequences

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Sign language recognition (SLR) remains a challenging task due to complex spatio-temporal dependencies, high inter-signer variability, and background clutter in real-world environments. To address these challenges, we propose a hybrid deep learning framework that combines YOLOv11 for spatial feature extraction with a Long Short-Term Memory (LSTM) network for temporal sequence modeling. YOLOv11 introduces architectural innovations such as C3k2 modules, Spatial Pyramid Pooling–Fast (SPPF), and C2PSA (Cross-Stage Partial with Spatial Attention), which improve multi- scale feature aggregation while reducing parameter count. These improvements yield superior localization accuracy and efficiency compared to YOLOv8 and YOLOv10, making YOLOv11 particularly well-suited for real-time hand gesture detection. In our framework, YOLOv11 detects and tracks hand regions and key gestures at speeds exceeding 35 fps, achieving 97% mAP@0.5 on custom gesture datasets. The extracted embeddings are sequentially fed into a stacked LSTM, which models

the temporal dynamics of hand motion and captures long-range dependencies essential for recognizing continuous signing. Evaluations on the RWTH-PHOENIX-Weather 2014T dataset and a custom isolated sign dataset demonstrate that our YOLOv11+LSTM model achieves a 20% relative improvement in sequence-level accuracy and reduces Word Error Rate (WER) by 12% compared to conventional CNN–LSTM baselines. Ablation studies further confirm that YOLOv11's spatial attention mechanisms play a critical role in suppressing background noise and enhancing signer- independent recognition. This research demonstrates that integrating YOLOv11's efficient, attention-driven detection with LSTM's temporal learning yields a robust, real-time SLR system. The framework is scalable to diverse sign languages, supporting practical deployment in assistive technologies and human–computer interaction applications.

Keywords: YOLOv11, LSTM, Deep learning, Real-time sign language recognition, Human–computer interaction, Sequence modeling

IT-2044: Smart Bluetooth-Controlled Robotic Car for Remote Navigation and Obstacle Detection

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The proposed project aims to design and develop a Bluetooth-controlled robotic car that can be operated wirelessly using a smartphone application. The system enables the user to control the car's movement (forward, backward, left, and right) through Bluetooth communication with an onboard microcontroller such as Arduino or ESP32. The car will also include ultrasonic sensors to detect and avoid obstacles in real time, ensuring smooth navigation. The Bluetooth interface provides a simple and cost-effective solution for short-range wireless control without requiring an internet connection. The project demonstrates the integration of embedded systems, wireless communication, and sensor-based automation, making it a valuable educational model for understanding the fundamentals of robotics and IoT-based control systems.

Keywords: Sensor-based Automation, IoT-based control systems, Bluetooth communication, Bluetooth-controlled robotic car

IT-2045: Smart Minutes: AI-Powered Meeting Recorder & Summarizer

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In modern workplaces, meetings are essential for planning, collaboration, and decision-making, yet documenting them manually is often inefficient and inaccurate. Minutes Mind is an intelligent system designed to automatically record, transcribe, and summarize meetings using artificial intelligence and speech recognition technologies. The system captures audio through a

microphone, converts speech into text using advanced models such as Whisper AI, and then produces a concise summary of the discussion through natural language processing (NLP). The initial version of Minutes Mind is developed as a desktop-based application using Python, allowing users to start, stop, and save meetings with ease. Each meeting's transcription and summary can also be stored and accessed via a simple web interface for future reference. In the advanced phase, Minutes Mind will be integrated with a Raspberry Pi and biometric authentication to create a portable, secure device capable of identifying authorized participants and generating personalized meeting records. By automating the entire documentation process, Minutes Mind enhances productivity, ensures accuracy, and provides a smarter way to manage meeting minutes in both professional and academic environments.

Keywords: Raspberry Pi, Natural language processing (NLP), Minutes Mind, Artificial intelligence, Whisper AI

IT-2070: AgriSmart: IoT-Enabled Intelligent Farming and Market Information System

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Agriculture plays a vital role in the economy, but traditional farming methods often face challenges like unpredictable weather, inefficient water use, and lack of timely market information. The AgriSmart: IoT-Enabled Intelligent Farming and Market Information System aims to solve these issues through smart technology integration. This system uses Internet of Things (IoT) devices to collect real-time data from the field, such as soil moisture, temperature, and humidity, enabling better understanding of crop conditions and improving overall farm management. AgriSmart also features an automated irrigation system that adjusts water supply based on soil data, ensuring optimal water usage and minimizing wastage. It integrates real-time weather forecasting to help farmers plan their activities like irrigation, fertilization, and harvesting more effectively. With these automated and data-driven features, the system reduces manual Labor and promotes sustainable farming practices. Additionally, AgriSmart provides daily crop market updates to help farmers make smart selling decisions. By combining IoT technology with data analytics and market intelligence, this system empowers farmers to increase productivity, reduce costs, and enhance profit margins. Overall, the project promotes a modern, efficient, and smart approach to agriculture, contributing to the advancement of precision farming and rural development.

Keywords: Internet of Things (IoT), AgriSmart, Automated Irrigation System, Whisper AI

IT-2071: Automatic Solar Tracking System

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The Automatic Solar Tracking System is a smart and energy-efficient solution that aims to improve the performance of solar panels. In traditional systems, fixed solar panels cannot follow the movement of the sun, which reduces the amount of sunlight they capture and lowers power output. To overcome this issue, the proposed system uses Arduino technology, light sensors (LDRs), and a motor mechanism to automatically rotate the panel toward the sun's direction throughout the day. In addition to tracking, the system features an automatic cleaning mechanism that removes dust from the panel's surface when performance drops, and a real-time monitoring system that displays key information such as voltage, current, sunlight intensity, and battery status. This smart control ensures the panel always operates at its best possible efficiency. By integrating embedded systems with renewable solar energy, this project provides a low-cost, reliable, and eco-friendly solution for improving energy production. It can be effectively used in homes, educational institutions, and rural areas where regular maintenance is difficult, promoting the wider use of clean and sustainable energy.

Keywords: Light sensors (LDRs), Automatic Solar Tracking System

IT-2072: Smart Audio Guide Companion

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The Smart Audio Guide Companion is an innovative system designed to transform and enhance visitor experiences in museums, exhibitions, and art galleries through intelligent automation. Traditional museums often rely on manual guides or printed descriptions, which can limit engagement and accessibility for visitors. To address this problem, this project introduces a pair of smart headphones that automatically play relevant audio information when a visitor approaches any exhibit or artwork. Using Bluetooth Low Energy (BLE) beacons, NFC tags, or QR code recognition, the system detects the visitor's proximity and delivers accurate, pre-recorded, or AI-generated audio content without requiring any manual interaction. A key feature of this system is its multi-language audio support, allowing visitors to listen to exhibit information in their preferred language such as Urdu, English, or other regional languages. This ensures inclusivity and accessibility for a diverse range of audiences. Additionally, a mobile and web application has been developed to manage multiple headphones, add or update exhibit information, and monitor overall device activity. By combining AI-based text-to-speech technology, smart automation, and multi-language functionality, the Smart Audio Guide Companion provides a modern, user-friendly, and interactive solution. It not only fills the gap in Pakistan's existing museum and gallery systems but also promotes digital transformation, cultural awareness, and smart tourism through the use of advanced, visitor-

focused technology.

Keywords: Bluetooth Low Energy (BLE), NFC tags, or QR code recognition

MATHMATICS

MTH-1279: The Evolutionary Trajectory of Fuzzy Metric Spaces: Introducing the q-Rung Orthopair Framework

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A Generalizations of Zadeh's Fuzzy Set Theory have consistently sought more powerful tools to model imprecision. Following the path from Fuzzy Metric Spaces to Park's Intuitionistic Fuzzy Metric Spaces, we introduce a significant leap forward: the q- Rung Orthopair Fuzzy (q-ROF) Metric Space. This novel q-ROF framework provides a superior analytical structure that directly addresses the limitations of existing models. Unlike previous versions, the q-ROF model greatly expands the permissible range for non-membership and membership grades. We illustrate this with a detailed example, showing how the q-ROF metric substantially increases the allowable selection and membership space, which is often restricted in the intuitionistic context. The paper fully defines the q-ROF metric space with clear examples and establishes its core topological characteristics, including the properties of open balls and convergence. Furthermore, we introduce the concept of q-ROF Menger boundedness. Crucially, the mathematical robustness of our generalization is confirmed by establishing fundamental theorems, including Baire's Theorem and the Uniform Limit Theorem, within the q-ROF metric space perspective. This work provides a powerful, generalized foundation for future research in topology, fixed point theory, and computational decision science.

Keywords: Fuzzy set, orthopair fuzzy

MTH-1582: A Study of Vibration Equation via Haar Wavelet Collocation Method

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In this study, the numerical solution of widely used vibration equation with very large membrane is considered. A collocation method with Haar wavelet (HW) is applied for this purpose. The algorithm based on the proposed method is very simple and easy to implement. Highly accurate approximate solutions are obtained with a reasonable number of collocation points. The method is tested upon several different exacts solutions of the vibration equation including polynomials and infinite series solutions. The numerical results confirm the accuracy, efficiency and robustness of the proposed method.

Keywords: Collocation method, Wavelet, Haar wavelet, Collocation points and Vibration equation.

MTH-1763: Reflected Thermoelastic Plane Waves through Nonlocal Thermo- Diffusive Semiconductors

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This study presents a groundbreaking investigation into the profound impact of Hall current on Wave propagation in advanced thermo-diffusive semiconducting materials. By harnessing a higher- order fractional heat equation and incorporating external magnetic fields, our research unveils the intricate dynamics governing wave behavior in these complex systems. The findings reveal significant alterations in wave speeds, amplitude ratios, and energy distribution, underscoring the critical role of Hall current in shaping the material's response. Furthermore, our analysis of reflected waves at the solid's free surface demonstrates the pivotal influence of Hall current on wave reflection characteristics. The incident longitudinal P-wave is shown to be significantly affected, with notable variations in amplitude ratios and phase shifts. These results have profound implications for understanding wave-matter interactions and optimizing material performance in various applications. This pioneering work offers profound insights into the underlying physics, with far-reaching implications for diverse fields, including mechanics, geophysics, and materials science.

Keywords: Nonlocal theory

MTH-1509: Study of Cosmic Gravitational Waves in Extended Gravity Theory

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This presentation focuses on the propagation of even modes of primordial gravitational waves (GWs) in an extended Bianchi type- I cosmological model within the framework of $f(R,T^{\psi})$ gravity. Beginning with the derivation of field equations for a locally rotationally symmetric Bianchi type-I universe, the study employs the Regge-Wheeler perturbation scheme to analyze polar wave dynamics. Perturbed field equations are formulated, and analytical solutions for the metric potentials are derived under specific assumptions. The temporal and spatial characteristics of wave propagation are explored, with graphical analyses highlighting the unique features of even wave modes in this cosmological framework. This work provides insights into the behavior of gravitational wave perturbations in anisotropic early universe models.

Keywords: Primordial gravity waves, Bianchi universes, Modified gravity

MTH-2008; Optimal Control Strategies for Chikungunya Virus in the Presence of Wolbachia and Sterile Mosquitoes

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This study develops a mathematical model for the transmission dynamics of the Chikungunya virus and explores strategies for its control. The model formulation includes the calculation of the basic reproduction number (R_0) to assess disease persistence, and the impact of birth and death rates of Wolbachia- infected mosquitoes is also examined. To control the outbreak, optimal control theory is applied using three interventions: release of Wolbachia-infected mosquitoes, release of sterile male mosquitoes, and public awareness campaigns. The resulting system of state and adjoint equations is solved numerically using the forward–backward sweep method. Simulation results are presented in detail for different scenarios, including single controls, double controls, combined controls, and the case without control. The comparative analysis confirms that the combined strategy yields the greatest reduction in infection levels, whereas single interventions are less effective. These findings emphasize that integrated vector management together with community-based approaches plays a crucial role in reducing the spread of Chikungunya. The study highlights how mathematical modeling and optimal control can provide valuable insights for designing practical strategies in global health management.

Keywords: Chikungunya, Mathematical Modeling, Basic Reproduction Number, Optimal Control, Wolbachia, Sterile Insect Technique

MTH-1235: Modelling and Analysis of HIV dynamical model with Fractal- Fractional Order and Nonlinear Autoregressive Neural Networks

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This paper develops a fractal fractional Mittag-Leffler operator to model the non-integer order evolutionary kinetics of the Human Immunodeficiency Virus (HIV). It analyzes the fractional- order HIV model qualitatively and quantitatively, wherein the uniqueness and existence of solutions are rigorously justified. Sensitivity analysis as well as stability of the model is performed. To achieve that objective, BRNAR-NNs are applied with a novel approach for the purpose of train the model of HIV Fractional Order Disease as follows. The solver implemented is a Grunwald-Letnikov-based one which is used in generating a dataset for that model. Numerical simulation for some varying fractional order ξ's is done while illustrating key effects of critical model parameters on disease dynamics which are then further elaborated with graphical representation. Using the MATLAB FD12, extensive Simulink results include mean square error, error histograms, and regression analysisto show that the approach used is accurate, reliable, and

effective. This validates the BRNAR-NNs for their efficacy in modeling HIV dynamics using statistical investigations.

Keywords: Fractal fractional operator, Human immunodeficiency virus, Nonlinear autoregressive neural networks, Bayesian regularization

MTH-1239: Application of Discrete Probability Distribution to Quantum Subclasses of Analytic Functions

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The basic q-calculus has been used to study several subclasses of analytical and univalent functions from various perspectives. We establish a quantum binomial probability series and determine the necessary and sufficient criteria for inclusion in the analytical subclasses $T*(\Upsilon, \beta)$and $C*(\Upsilon, \beta)$. In addition, we studied aq q quantum integral function connected to this series. We create the functional families, (l, P, u), (l, P, u) and the integral function Hq(l, P, u) by inserting q-binomial probabilistic distribution into the parameters of the analytical power series. These results may offer useful insights for quantum algorithms.

Keywords: Analytical function; q-difference operator; q-integral operator; q-binomial distribution; Univalent function

Optimizing Collective Motion in Self-Propelled Particle Systems: A Mathematical and Computational Study of Noise-Induced Order

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The emergence of collective motion in systems of self- propelled particles is a fascinating phenomenon observed in various biological and artificial contexts. This study investigates the impact of noise on the collective behavior of self-propelled particles through a combination of mathematical modeling and computational simulations. Our research reveals a striking result: the existence of an optimal noise level that maximizes collective motion. We demonstrate that this optimal noise intensity strikes a balance between disrupting local alignment and facilitating global coordination, leading to enhanced collective behavior. Our findings provide new insights into the role of noise in shaping the emergent properties of complex systems and have implications for understanding biological systems and designing artificial systems that harness collective motion.

Keywords: Self-propelled particles, collective motion, noise optimization, mathematical modeling, computational simulation

MTH-1649: Mathematical and Computational Modeling of Collective Motion of Self-Propelled Particles under Speed Variability

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Self-propelled particles (SPPs) are particles which adopt the mean direction of motion of their neighbors with some random perturbation. Collective motion of this type is widespread in nature, such as in bird flocks, fish schools, insect swarms, and bacteria colonies. It also plays a role in artificial systems such as swarm robots and autonomous vehicles. How these particles move collectively and when this collective movement fails is of interest in both natural and engineered systems. This paper looks at the influence of speed variability in particles, which are differences in the speed of particles, on coordinated movement. Speed variability implies that there are particles that are faster or slower than others. This may occur in living systems as a result of discrepancies in energy, strength or health. It may happen in machines because of mechanical constraints or setting of controls. We study this effect in a modified version of the Vicsek model, a popular model of collective motion. In the simulations we vary the degree of speed variability in a systematic manner and note the group behavior. The findings depict a definite trend. In the case of low or moderate speed variability, the particles can move collectively inan orderly manner, and as a whole stay aligned. But, in case the variability of speed is too high, the particles lose this coordination and the group dissolves into smaller, disordered clusters. This shift between ordered and unordered movement shows a boundary to the extent to which a group can allow variation and still be moving as a group. Such findings provide a better insight into the mechanism of coordinated movement in cases when the difference in speeds exists. They also provide realistic solutions to better control swarm robots, autonomous vehicles and crowd flow in order to maintain the groups together when the speed can vary.

Keywords: Self-propelled particles, Collective motion, Speed variability, Vicsek model, Active matter

MTH-1990: Graph-Theoretic Dimensions and Regression Analysis of Anti- Cancer Drugs Using Python

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This work investigates the structural properties of anti-cancer drug molecles through graph. Theoretic and computational approaches. Each drug is modeled as a molecular graph, and the metric dimension and edge metric dimension are calculated to analyze vertex and edge resolvability. The formulations and computations were implemented using Python algorithms, enabling efficient extraction of graph invariants. Furthermore, a regression model was applied to the calculated dimensions to identify correlations and predictive patterns among the molecular structures. The results demonstrate that combining graph theory with computational tools and statistical modeling offers valuable insights into the

structural complexity of anti- cancer drugs, with potential applications in drug design and cheminformatics.

Keywords: Metric dimension, edge metric dimension

MTH-1470: Dimensional Estimation on Edge Metric Dimension of Germanium Antimony Telluride

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Graph Theory is a branch of mathematics that focus on the study of relationships among objects, furthermore chemical graph theory is the branch which deals with the structure of the atom and their bonding in a chemical reaction for molecule formation. In many different fields, mathematics is essential. We use many formulations and representations to study various properties and characteristics of chemical structure graphs. The edge metric dimension of a graph G is the smallest cardinality of a set of edges, known as the edge metric basis, which uniquely determines the distance between all pairs of vertices in the graph. In this article, we compute the edge metric dimension of chemical structure of Germanium Antimony Telluride.

Keywords: Resolving set, Metric basis, edge metric dimension, germanium antimony telluride

MTH-1508: A Mask-Based Link Between Even-Point Dual Binary and Quaternary Refinement Schemes

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Refinement schemes offer a robust and systematic iterative framework for generating smooth curves and surfaces from a discrete set of points. In this study, we establish a formal connection between even-point dual binary approximating refinement schemes and their quaternary counterparts. Specifically, we demonstrate that each 2-point binary refinement scheme yields a corresponding 2-point relaxed quaternary refinement scheme. Similarly, the 4-point, 6-point, and 8- point binary refinement schemes lead to the construction of 5-point, 8- point, and 11-point relaxed quaternary refinement schemes, respectively. To achieve this, we develop a set of general refinement rules for quaternary schemes that require only the mask of the corresponding binary refinement scheme. The applicability and effectiveness of the proposed method are validated through implementations using various existing schemes, confirming its versatility and computational efficiency.

Keywords: Curve Refinement Scheme

MTH-1471: Computational Aspects of Metric Dimension of Hexagonal Linear Chains

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The metric dimension of a graph is the smallest number of vertices that can uniquely identify all other vertices in the graph. The set is known as resolving set if each pair of vertices has unique representation. Metric dimension has various applications including network navigation, sensor placement and robot localization. In this research, the metric dimension of hexagonal linear chain has been computed.

Keywords: Metric dimension, resolving set, metric basis, hexagonal linear chain

Logarithmic Coefficient Bound for Special Subclasses of Analytic Functions

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The study extends the classical theory of Bazilevič functions by introducing a generalized class incorporating both growth and rotational distortion parameters. We establish sharp bounds for logarithmic coefficients and Taylor series coefficients, revealing how the interaction between these parameters control function behavior. Our main results provide a unified framework that recovers known special cases while generating new insights for the extended class. The analysis combines techniques from geometric function theory with innovative applications of integral mean estimates and coefficient bounds. Key findings demonstrate the optimality of these bounds through comparison with extremal functions and highlight the delicate balance between growth and rotation in coefficient estimation. This work not only advances the theoretical understanding of Bazilevič-type functions but also provides tools for further investigations in complex analysis. The results open several research directions, including optimization of bounding constants and exploration of geometric properties in this broader functional space.

Keywords: Analytic, Univalent, Starlike, Bazilevič , Convex, Normalized, and Caratheodory Class.

MTH-1710: Some Geometric properties of Subclasses of Analytic Functions

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The aim of this study is to define subclass of analytic functions in the unit disk U, which extends some previous well-known classes defined by different authors. The geometric properties of subclasses of analytic functions such as inclusion results, radius problems, are discussed.

Keywords: Univalent Functions

MTH-1234: Novelty of Several Dynamic Estimates Refined on Time Scales

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The present research work proposes some dynamic variants of Bergström's inequality based on Milne's and Callebaut's inequalities and reverse Rogers–Hölder's inequality on times cales. Time scale results are the generalized forms of their discrete, continuous and quantum versions. It is hoped that in between a dynamic estimate, there are infinitely many other dynamic estimates. We give some stronger versions of Bergström's inequality based on Milne's and Callebaut's inequalities helpful for the Heisenberg uncertainty principle. Further, we establish several fractional dynamic versions of classical inequalities.
Keywords: Bergström's inequality, Rogers–Hölder's inequality

MTH-1497: Shadows and Energy Emission from Black Bounces

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Black holes and black bounces serve as profound laboratories for probing the fundamental nature of spacetime and gravity. This presentation examines the intricate interplay between light propagation, gravitational lensing, and shadow formation inthese exotic geometries. In addition, we explore greybody factors, bridging quantum processes with classical gravitational effects, to illuminate the energy dynamics in the vicinity of compact objects. Adopting a unified perspective, the study demonstrates how these phenomena collectively advance our understanding of the universe's most enigmatic and extreme regions.
Keywords: Gravitational lensing, Black bounces, Energy Emission

MTH-1498: Application of fixed-point theory and wave solutions for fractional convection-diffusion system

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In this article, the two-dimensional time fractional unsteady convection-diffusion system is under consideration. In particular, these practicable implications include turbulence, heat transfer, fluid flow, traffic flow, and modeling of gas dynamics. The existence of results and uniqueness is proved by applying the fixed-point theory with the help of some well-known results and theorems such as the contraction mapping theorem with Lipschitz condition, and Schauder's fixed point theorem. Mainly, we find the exact solitary wave solutions of the underlying model. For this sake, the new extended direct algebraic method is applied and the solutions are obtained in the form of dark, singular, complex, combo, trigonometric and rational solutions. Further, we draw 3D plots to show the behavior of these solutions by choosing the different values of parameters. The aim of this study is to investigate the advantage of using the mixed physics informed neural networks (MPINN) to perform a simulation for such phenomena.

A hypothetical situation was considered in which an obstacle arose at the channel of the ureter during its peristaltic motion. This situation is known as a kidney stone disease. The momentum conservation governing equations is considered for the case of incompressible Newtonian fluid and the dimensionless corresponding form is introduced. The contour plots of the pressure and the velocity fields are illustrated for different stone shapes. Also, the shear stress is obtained at the surface of Lumen. Our findings show the applicability of the MPINN for obtaining reliable results for such crucial situations.

Keywords: Existence, Compactness, Caputo operator, New extended direct algebraic method, Wave transformation, Soliton's solutions

MTH-1639: Alpha Cut Approach to Solve of Fuzzy Equations

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Fuzzy equations involve uncertainty and imprecision in mathematical models, using fuzzy numbers to represent these concepts. Solutions are obtained using method the α-cut method which relates fuzzy sets to crisp intervals and then after the finding the solution from crisp intervals we convert it into fuzzy form. We formulate the linear and quadratic equations of the types $A + X = B$, $A \cdot X + B = C$, and $A \cdot X2 + B \cdot X + C = D$ where the elements A, B, C, and D are fuzzy numbers.

Keywords: Fuzzy equations

MTH-1654 Authentication Scheme Based on Latin Square

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We explore the values of constructing authentication schemes using Latin squares, analyze their security features, and determine their potential applications.

Keywords: Authentication Scheme, Latin Square, Quasigroup, Cryptography, Security, Graphical Authentication, SBox Encryption

MTH-1496: Qualitative Analysis of Fractional Delay Differential Equations with Time Singularities

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We formulate a novel fractional delay differential equation (FDDEs) incorporating time singularities and integral boundary conditions. Subsequently, will qualitatively examine the proposed singular FDDEs with integral boundary conditions (IBC). Using the tools of fixed-point theory (FPT) we will establish conditions for the uniqueness and existence of solutions. While in the second part we consider the sequence of singular FDDEs with integral boundary conditions and will analyze the connections among solutions of a sequence of problems and solutions of a differential equation satisfying the integral boundary condition. Additionally, for the first time different types of Ulam Hyers (UH) types of stability analysis will be examined for the proposed model.

Keywords: Singular Fractional Differential Equations; Time Singularity; Delay Term; Integral Boundary Conditions; logical phenomena, neural networks, fluid dynamics

MTH-1482: Exploring Fault tolerant Metric Dimension of Linear Naphthalene

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The fault-tolerant metric dimension of a graph extends the concept of the metric dimension by ensuring unique vertex identification even when any single landmark vertex fails. This robustness is crucial for applications in network navigation and molecular graph analysis. In this study, we examine the fault-tolerant metric dimension of linear naphthalene modeled as graph. In this molecular graph atoms are represented as vertices and bonds as edges, where resolving sets help to uniquely identify atoms based on distances. By analyzing the structural features such as symmetry and connectivity, we determine exact fault-tolerant metric dimension values and establish bounds for these chemical graphs. Our findings reveal that highly connected and symmetrical molecular graphs exhibit lower fault-tolerant metric dimension, indicating stronger fault tolerance. This work enhances the understanding of structural resilience in chemical graph theory and aids the design of robust molecular identification and sensing systems.

Keywords: Resolving set, metric dimension, fault- tolerant metric dimension, linear naphthalene

MTH-1585: Analysis of discrete probability distribution on certain subclasses of analytic function

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This thesis investigates the interplay between discrete probability distributions and specific subclasses of analytic functions within the open unit disk. Motivated by the growing applications of distribution series and generating functions in geometric function theory, we focus on extending classical and neutrosophic forms of discrete distributions, particularly the Pascal (negative binomial) distribution, to characterize analytic function classes through their coefficient conditions and moment inequalities. Using symbolic expansions and distribution-based operators, we derive new sufficient conditions for functions to belong to subclasses such as (η). This study provides sharp inequalities involving distribution parameters, trigonometric coefficients, and functional moments, thereby refining existing results and revealing deeper structural connections between probability models and analytic univalent or bi-univalent function classes. Our analysis demonstrates that discrete probabilistic models serve not only as tools for generating new subclasses but also as frameworks for deriving coefficient estimates and growth theorems in complex analysis.

Keywords: Analytics, star-like, neutrosophics, discrete probability, distribution pascal

MTH-1239: Analysis of Plane Waves in Nonlocal Generalized Thermoelasticity

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This study develops a new theoretical framework by combining Eringen's nonlocal elasticity model with the Lord-Shulman (LS) theory of generalized thermoelectricity. The resulting field equations and constitutive relations are used to analyze the propagation of planar thermoelastic waves in an isotropic, homogeneous, nonlocal thermoelastic material. The analysis reveals two coupled longitudinal wave modes and a distinct shear-type wave. The presence of nonlocality leads to dispersive and attenuating behavior for all wave types. Notably, the shear wave always exhibits a critical frequency, while the longitudinal waves may experience one conditionally. Furthermore, the reflection of thermoelastic waves is investigated for longitudinal waves incident on a stress-free, thermally insulated boundary in a half-space.

Keywords: Plane Waves, Nonlocal, Generalized Thermoelasticity, Analysis, Thermoelasticity, Waves

MTH-1823: Characterizing Bounds on Zagreb Indices in Trees with a Specified Metric Dimension

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Let $G = (V, E)$ be a simple graph, where V denotes the set of vertices and E represents the set of edges. The first Zagreb index is defined by $Z_1(G) = \sum_{v \in V(G)} d(v)^2$, and the second Zagreb index is given as $Z_2(G) = \sum_{uv \in E(G)} d(u)d(v)$. The metric dimension of a graph refers to the smallest possible size of a resolving set, which is a subset of vertices such that the distances from these vertices uniquely determine the position of every other vertex in the graph. In this paper, we investigate bounds for the Zagreb indices of trees with respect to their order and metric dimension. Moreover, we characterize the trees that attain these extremal bounds, offering new insights into how the metric dimension affects the behavior of the Zagreb indices in tree structures.

Keywords: Zagreb indices, metric dimension

MTH-1597: AI-based simulation investigates thermal transfer in polymer- CNT hybrid nanofluid between planes

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Present study is to investigate the flow of hybrid-nanofluid (Hnf) with thermos-material exchange considering the influence of a activation energy and magnetic effect beyond parallel, twin revolving planes, incorporating Artificial Intelligence AI-based machine learning technique. Artificial intelligence is rapidly advancing across various fields, providing innovative solutions and significantly improving the ability to analyze complex scenarios and pattern in diverse areas. The critical parameters like Prandtl number, suction/injection parameter, Schmidt number, and material parameter are taken into consideration in order to understand the flow characteristics and heat transfer rates in this research. To synthesize the Hnf, polymer/CNT matrix nanocomposites (MNCs) are dissolved in water. These MNCs, made from polymer and CNT, demonstrate exceptional properties and high efficiency. Their outstanding thermophysical characteristics make them highly valuable in the field of engineering and biomedical research. We have expressed the fluid flow as a system of partial differential equations (PDEs) then by the appropriate similarity transformations, the system of nonlinear PDEs is converted into a set of nonlinear ODEs, thereby reducing the complexity and order of the system and solved numerically using the MATLAB. It is also noted that the fluid velocity declines due to the combined effects of suction/injection, Reynolds number, and the concentration of polymer/CNT MNCs. As the concentration of polymer/CNT MNCs in water increases, both energy and mass profiles are reduced. The energy field increases as a result of the heat source term, while the concentration field diminishes under the influence of the Schmidt number.

Keywords: Artificial Intelligence; Machine Learning; Schmidth number; Thermophysical; Carbon Nano Tubes.

MTH-1630: Eccentricity based topological indices of some graphs

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Let G (V, E) be a graph of order n and size m. The eccentricity value of vertex u of a graph G is denotes e(u),that is the length of largest path between a vertex u and any other vertex v of G. e(u) = $maxv \in V(G) d(u, v)$ A topological index is a numerical parameter mathematically derived from the graph. They describe the arrangement of atoms and bonds within a molecule providing insights into its chemical properties and behavior. In this paper we will compute eccentricity based topological indices of some graphs. Eccentricity based indices are calculated based on the eccentricity of vertices in the graph.

Keywords: Distance, Eccentricity, Topological indices

MTH-1709: Wave behavior in Porous Thermoelastic Non-Local Solids

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This paper explores the behavior of time-periodic plane waves as they move through an unbounded nonlocal thermoelastic medium that contain voids. The analysis identifies the existence of three distinct types of coupled compressional waves and separate shear wave, each travelling at unique velocities. All wave types demonstrate dispersive characteristics, meaning their speeds depend on frequency. However, the compressional (dilatational) waves exhibit attenuation, while the shear(transverse) wave propagates without loss of amplitude. The propagation of the compressional waves is significantly affected by the presence of voids, thermal effects, and the material's nonlocal elastic response. In contrast, the transverse wave is influenced only by the non-local elastic behavior and remains unaffected by voids and thermal factors. For a specific theoretical framework, numerical simulations have been conducted to assess how variables such as wave frequency, porosity, thermal coupling, and nonlocal elasticity impact the wave speeds, attenuation rates, and energy dissipation characteristics of each wave mode. The resulting data are illustrated through graphs and thoroughly interpreted.

Keywords: Attenuation, dispersion, elastic, nonlocal, phase speed, specific loss, thermal, void wave

MTH-1716: Reflection and propagation of CP-Wave in type II thermoelastic nonlocal solids

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In this research paper, the investigation of the reflection and propagation of CP-wave in thermoelastic nonlocal medium is carried out. The problem is solved through the Green and Naghdi theory II. The nonlocal generalized thermoelasticity is applied to study the wave behavior. The reflection phenomenon of the CP-wave is also discussed at the free boundary. For reflected waves the amplitude and energy ratios are analytically determined. The phase speeds, amplitude ratios, attenuation coefficients and corresponding energy ratios of the reflected waves are studied under the effect of nonlocal parameter for the case of special solid. is presented graphically and analysis of these results is given.
Keywords: Green and Nagdhi theory II; nonlocal; dispersion; attenuation; reflection; energy partition

MTH-1484: Exploring the Metric Dimensions of Graphene and Unveiling the Intricacies of Atomic Structure

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Graphene, a single layer of carbon atoms arranged in a two- dimensional honeycomb lattice, has emerged as a revolutionary material due to its exceptional electrical, thermal, and mechanical properties. These attributes have positioned it at the forefront of research in nanoelectronics, quantum physics, and materials science. This study presents a detailed investigation into the metric dimensions of graphene, a graph-theoretical measure that captures the minimal number of reference points required to uniquely identify all other points in a network. Understanding this invariant provides insights into the topological efficiency and structural uniqueness of atomic arrangements within graphene. By modeling the atomic structure of graphene as a graph, we analyze how its metric dimension contributes to spatial resolution and control in nanoscale systems. Our exploration considers how variations in lattice structure, boundary configurations, and external parameters such as temperature, mechanical stress, or pressure impact the metric dimension and, consequently, the performance of graphene in real-world applications. We also discuss the role of symmetry and connectivity in enhancing resolving power, which is crucial for fault detection, signal routing, and material optimization. Furthermore, this research highlights the broader implications of integrating mathematical graph theory with atomic- scale materials modeling. It provides a foundation for designing efficient graphene-based devices with improved functionality and resilience. By unveiling the intricacies of graphene's atomic structure through the lens of metric dimension, this work opens new avenues for theoretical and applied innovations in nanotechnology and advanced materials engineering.

Keywords: Graphene, Metric Dimension, Atomic Structure, Nanoelectronics, Structural Optimization.

MTH-1483: Characterizing Fault-Tolerant Resolving Sets in Kekulene Graphs: Implications for Cryptographic Applications

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Graph invariants are pivotal tools for analyzing complex structures across diverse fields. The metric dimension, measuring the smallest set of vertices required for unique vertex identification, is fundamental. Building upon this notion, fault-tolerant metric dimension ensures robust identification, even amid vertex disruptions. This study delves into fault-tolerant resolving sets within kekulene graphs, preserving unique vertex identification despite potential vertex perturbations. Notably, this exploration marks the pioneering investigation of metric dimension and fault-tolerant metric dimension tailored to Kekulene graphs, adding a unique scholarly contribution. Furthermore, the methodologies developed extend beyond Kekulene graphs and apply to a broader spectrum including hollow-coronoid and hollow hexagon graphs. By elucidating fault-tolerant resolving sets, this research advances our understanding of kekulene graphs and their metric dimensions while illuminating significant implications for cryptographic applications. Bridging graph theory with molecular structures, this interdisciplinary endeavour showcases how robust identification methods bolster security and reliability in cryptographic systems. These insights underscore the potential for enhancing cryptographic algorithms by integrating fault-tolerant metric dimensions, ensuring heightened resilience and security.

Keywords: Cryptography, Metric dimension (MD), Resolving set (RS), Fault-tolerant metric dimension (FTMD). Cardinality, Molecular graphs

MTH-1475: Computational Spatio-temporal patterns and Turing–Hopf bifurcation in a spatially extended prey–predator model

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In this talk, a ratio-dependent prey–predator system is considered. The stability analysis is carried out about the coexistence equilibrium. The conditions for the Hopf bifurcation and Turing instability are derived. These conditions help to analyze the formation of patterns in the prey–predator system. The dispersion relation shows the changing behavior of the Hopf bifurcation and Turing instability from stable to unstable. The bifurcation and Turing instability simulation divide the parametric space into 4 Regions. Different types of Turing patterns are produced. The numerical solution of the model is obtained by a positivity preserving finite difference scheme. The analysis of the scheme is also established. The 3D and 2D plots are drawn for the various parametric values. The numerical simulations support the analytical results.

Keywords: Population dynamics, Turning patterns, Computational scheme, Results

MTH-1551: A Fractional Order Physics Informed Neural Network Framework for Modeling and Control of Alzheimer's Disease

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Alzheimer's disease (AD) is a progressive neurodegenerative disorder characterized by complex biochemical and cellular interactions that evolve over long time scales. In this study, we develop a novel fractional order mathematical model of AD using the Caputo derivative, which enables the explicit representation of long term memory and hereditary effects features that are essential for accurately capturing the slow cumulative nature of neurodegeneration. The proposed model incorporates the dynamics of neurons, amyloid beta (Aβ) aggregates, tau protein tangles, and microglial responses, thus providing a comprehensive framework for simulating the intricate pathological mechanisms underlying disease progression. A detailed sensitivity analysis is conducted to determine the relative influence of each pathological factor, revealing amyloid toxicity as the dominant driver of neuronal loss and emphasizing its critical role in AD pathophysiology. To address potential intervention strategies, we formulate an optimal control problem that adaptively regulates preventive and therapeutic measures over time, aiming to minimize neuronal damage while balancing treatment costs. To complement the analytical approach, a Physics Informed Neural Network (PINN) is developed to learn the system dynamics directly from noisy or incomplete data while enforcing biological and physical constraints derived from the model equations. Comparative experiments demonstrate that the PINN achieves superior predictive accuracy and robustness relative to conventional neural networks, particularly under data scarcity, by leveraging embedded domain knowledge. By uniting fractional calculus, optimal control theory, and physics-informed machine learning, this work not only advances the computational modeling of Alzheimer's disease but also offers practical insights into optimizing therapeutic interventions. The integrated methodology has the potential to support clinical decision making and guide the design of effective, personalized treatment strategies.

Keywords: Alzheimer's disease, fractional calculus, optimal control, machine learning, physics informed neural networks

MTH-1556: On computation of neighbourhood degree sum-based topological indices for zinc-based metal–organic framework

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The strong interactions between metal ions and organic ligands give rise to the permeable materials known as metal organic frameworks (MOFs), which have a huge porosity volume, exceptional chemical stability, and a distinctive structure. Research on the synthesis, structures, and characteristics of different MOFs shows their value in a range of applications, such as gas storage, heterogeneous catalysis, energy storage devices with appropriate electrode materials, and chemical evaluation. Based on the underlying molecular graph or framework, a topological index a numerical invariant predicts the physicochemical characteristics of chemical entities. Two distinct zinc- based MOFs zinc oxide and zinc silicate MOFs are examined in this article. For these frameworks, we calculate 14 neighborhood degree sum-based topological indices, and we provide numerical and graphical representations of each of the 14 indices stated above.

Keywords: Neighborhood degree, topological indices, zinc-based metal–organic networks.

MTH-1557: Computing the Edge Irregularity Strength of Some Classes of Graphs

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For a simple graph G, a vertex k-labeling $\phi:V(G)\rightarrow\{1,2,\ldots,k\}$ is termed edge irregular if every edge $xy\in E(G)$ satisfies $w_\phi(xy)=\phi(x)+\phi(y)$, and all such weights are distinct. The minimum such k is called the edge irregularity strength of G, denoted es(G). This paper investigates the edge irregularity strength of triangular grid graphs, particularly focusing on the subclass L_2^m, for which we determine the exact value of es(L_2^m). For the general case L_n^m, we propose a labeling strategy and derive a near-optimal upper bound. Furthermore, we establish a tight upper bound for cycle graphs C_n, improving upon existing estimates. A significant contribution is the exact determination of the edge irregularity strength for the rooted product graph $C_n\circ P_2$, where each vertex of the cycle is extended by a path of length two. Our results are supported by constructive labeling schemes and rigorous combinatorial arguments, offering new insights into the structural behavior of edge irregular labelings across diverse graph families. Edge irregular labeling is a compelling area of graph theory that explores vertex assignments yielding distinct edgeweights.

Keywords: Edge irregular labeling, edge irregularity strength, triangular grid graph, cycle graph, rooted product graph

MTH-1561: Wiener Polarity Type Invariant of Some Nanostructures

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The Wiener polarity index is a recognized distance-based topological invariant which is of major importance in examinations of chemical and nano-structural graphs. It is defined as the number of unordered pairs of vertices which are separated in the graph by three edges (of length three.) Here in this paper, we discuss the Wiener polarity type invariant of some classes of nanostructures, such as nanotube, nanoribbon and some structures of dendrimers. In every structure we provide concrete formulas and, in selected cases, strong bounds with combinatorial justification. We have exploited the structural decomposition and counting methods to find closed-form expressions to find the role of the molecular geometry in the value of Wiener polarity. Besides giving a contribution to the theoretical development of distance-based graph invariants, the results also present a possible avenue of applications in the modeling and characterization of nanoscale materials.

Keywords: Wiener polarity index, nanostructures, nanotubes, nanoribbons, dendrimers, distance-useful topological indices

MTH-1567: Optimization Energy Storage in Smart Grids Via Advanced Graph Theory

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The integration of renewable energy sources into modern power systems has introduced significant challenges in energy storage optimization within smart grids. Efficient energy storage management is critical for ensuring grid stability, reducing operational costs, and enhancing sustainability. This paper explores an advanced approach to optimizing energy storage in smart grids using graph theory. The smart grid is modeled as a graph G(V,E), where V represents nodes such as energy sources, storage units, and consumers, and E denotes the set of edges representing power flow and communication links. We formulate the optimization problem as minimizing the total energy loss: min $\sum_{(i,j)\in E}$ wij fij where w_ij is the weight (loss factor) on edge (i,j) and f_ij is the energy flow. Advanced graph-theoretic algorithms such as minimum spanning trees, shortest path, and network flow optimization are employed to enhance energy routing and storage utilization. Additionally, graph partitioning and clustering techniques are applied for decentralized energy management and demand response strategies. Simulation results demonstrate that graph-based optimization significantly improves energy storage efficiency, reduces peak load stress, and supports real-time decision-making in smart grids. This research provides a scalable and robust framework for future smart grid architectures, paving the way for intelligent, resilient, and energy- efficient power systems.

Keywords: Smart Grid, Energy Storage, Graph Theory, Network Optimization, Load Balancing

MTH-1584: On Topological Indices of Certain Interconnection Network

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QSAR/QSPR studies use physicochemical parameters and topological indices (e.g. Randic, ABC, GA) to predict the bioactivity of chemicals. A topological index is created by converting a chemical structure into a numerical value. Topological indices connect with physicochemical parameters such as boiling point, stability, and strain energy of chemical compounds. Graph theory has found extensive use in this field of study. Hayat and Imran (2014) conducted a recent study on the topological features of networks [13]. In this research, we expand the concept to interconnection networks and derive analytical closed results of the general Randic' index RaðGÞ for different values of "a" in butterfly and Benes networks. We also calculate first Zagreb, ABC, and GA indices for these important types of networks. We create two new mesh derived networks by applying graph operations to m-n mesh networks. We next analyze topological indices for these networks.

Keywords: General Randic index ,Atom-bond connectivity (ABC) index, Geometric-arithmetic (GA) index, Butterfly network, Benes network Mesh Derived Network

Computation of topological indices for the product of graphs

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In graph theory, topological indices are parameters of a graph invariant under graph isomorphisms and which are of significant concern to mathematical chemistry, especially in molecular structure Series. In the present paper we explore how different topological indices are calculated on product graphs and particularly such significant operations as Cartesian product, tensor product and rooted product. Formulas of specific types of Wiener-type, Zagreb and eccentricity-based indices are obtained on particular classes of product graphs. In a number of instances, we give the closed-form expressions, and in others we obtain the tight bounds which are supported by combinatorial arguments. The challenges determine the results which are explained in portions to depict the structure properties and possibly chemical applications. The present paper can contribute to the existing literature with the new information on the interrelation between graph manipulations and topological indices, providing chemists with new instruments to analyze their graphs and network scientists with new tools to analyze their networks.

Keywords: Topological indices, product of graphs, Cartesian product, tensor product, rooted product, Wiener index, Zagreb indices.

Super (a,d)-H-anti-magic labeling of subdivided graphs

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This paper examines $super\ (a,\ d) - total\ Y - star\ (K1,3)$-anti-magic labeling for the family of flower snark graphs Fn with $n \geq 3$. A total labeling is defined as a bijection from (Fn) (Fn) onto$\{1,2, \ldots, |V(Fn)| + |E(Fn)|\}$, while the super condition requires that vertices receive the smallest possible labels. A labeling is called $(a, d)- total\ Y - star\ anti - magic$ if, for all subgraphs of Fn isomorphic to Y-Star, the total weights-obtained by summing the labels of the vertices and edges in the subgraph-form an arithmetic progression with first term a and common difference d ≥ 0. We provide explicit constructions of such labeling for all n≥3 establishing that flower snark graphs admit super (a,d)- total Y star K1,3 -anti-magic labeling for a broad range of d values. The case d = 1 yields consecutive integer weights, while other values of d produce evenly spaced sequences of total weights. A further contribution of this work is the investigation of the prime arithmetic progression case, where all terms in the weight sequence are prime numbers. This condition is highly restrictive, yet we demonstrate its feasibility for various instances within the flower snark family. The labeling techniques introduced are constructive and adaptable, extending naturally to other cubic snark graphs such as the generalized Jahangir graphs J2k+1, The results presented contribute new infinite families of graphs possessing both general and prime AP super (a,d)-total Y-star K1,3 -anti-magic labelings, thereby enriching the study of anti-magic labelings in cubic and snark graph classes.

Keywords: Super (a,d)-total Y star K1,3- anti-magic labeling, flower snark graph,arithmetic progression, prime arithmatic progression

MTH-1558: On e-super (a,d)-edge antimagic total labeling of some Graphs

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A graph G=(V,E) be a finite, simple, connected graph with

|V|=p and|E|=q. An edge-antimagic total labeling is a bijective functionf:V(G)∪E(G) to {1,2,…,p+q}, such that for every edge e=uv∈E(G), the edge weight defined by w(e)=f(u)+f(e)+f(v) takes distinct values. If these weights form an arithmetic progression with initial term a>0 and the common difference d≥0, then the labeling is called to be an (a,d)-edge antimagic total labeling. Moreover, if the labeling satisfies the condition that edge labels are 1,2,…,q, and the vertex labels are q+1,q+2,…,q+p, then it is called an e-super (a,d)-edge antimagic total labeling. This study investigates the existence and explicit construction of e-super (a,d)-EAT labeling for three graph families: path graphs 〖P〗_n, odd cycle graphs 〖C〗_n, where n is odd, and even cycle graphs augmented with chords and diagonals ξ_nwheren=2k+2,k∈N. Labeling were first

derived for small instances and subsequently generalized through observed structural patterns. For each case, edge labels were assigned from 1,2,…,q, while vertex labels from q+1,q+2,…,q+p to preserve the e-super property. The research establishes bijectivity and sequential continuity without missing or repeating labels, supported by mathematical proofs in theorem form. Comparative analysis with traditional super (a,d)-EATL highlights structural differences, particularly in label assignment sequences. Potential applications include network design, cryptographic key generation, and modelling of ring topologies. Future work may extend these techniques to other graph classes, including trees, caterpillars, and related structures.

Keywords: Graph labeling, magic labeling, antimagic labeling, edge antimagic total labeling, edge weight.

MTH-1566: Shape Analysis in Computer Aided Design System

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Computer Aided Design (CAD) is an important industrial art used for designing, modelling and analysis of designs in industry. It has a significant influence on product cost, functionality and quality. One can review the features and shape of the product before its manufacturing. Therefore, it saves time, cost and labor.

Keywords: Shapes, Computer Aided Designs, Approximation, Geometric Approximation

MTH-1544: Automated Forecasting Fractal Algorithm for Simulation and Modeling of El Niño Southern Oscillation

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Reliable forecasting of El Niño Southern Oscillation (ENSO) phases can minimizethe risks in many critical areas including water supply, food security, health, and public safety on a global scale. In literature, several ENSO models are established but acquiring their accuracy is still questionable due to their chaotic behavior. Therefore, to confront this issue, the hybrid methodology of fractals and spline functions based on iterated function system and regression model is utilized in this article. To enhance their reliability and flexibility, an automated forecasting fractal algorithm with four free parameters and one risk factor (l_i,α_i ,β_i ,γ_i and δ_i) is introduced. This method is an innovative approach in the field of climate science to not only depict versatile ENSO forecasting models but also analyze their peaks depends on their risk factor.

Keywords: Modeling forecasting ENSO

STATISTICS

STAT-1555: A New Restricted Modified Ridge Type Estimator for the Poisson Regression Model

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For modeling count data, the Poisson regression model (PRM) is widely used when the response variable takes non-negative integer values and follows the Poisson distribution. However, strong correlations between explanatory variables lead to multicollinearity, which inflates the variance of the maximum likelihood estimator (MLE) and results in unstable parameter estimates. Multicollinearity can be mitigated by using biased estimators, such as the ridge estimator, to reduce the variance of regression coefficients. Another approach is to impose exact linear restrictions on the parameters in the regression model, which leads to the restricted maximum likelihood estimator (RMLE). The restricted Poisson ridge regression estimator (RPRRE), an existing method for handling multicollinearity in the PRM with exact linear restrictions, also deals with the issue of multicollinearity. We proposed another new biased estimator, the restricted modified ridge-type estimator for the PRM (RPMRTE), to further enhance performance the PRM's estimates under these conditions. The performance of the RPMRTE is compared with that of the RMLE and the RPRRE using the mean squared error (MSE) criterion. Both simulation studies and a real data application are presented to illustrate the theoretical results. The findings demonstrate that the proposed estimator outperforms the RMLE and RPRRE. Therefore, the RPMRTE is recommended for the PRM in the presence of multicollinearity and exact linear restrictions.

Keywords: Poisson Regression, Restricted Maximum Likelihood Estimator, Multicollinearity, Restricted Ridge Regression Estimator, Restricted Modified Ridge Type Estimator.

STAT-1755: Fractional Feature Transformation for Gene Expression-Based Cancer Classification and Analysis

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Accurate cancer classification using gene expression data is essential for early diagnosis and effective treatment planning. Gene expression datasets are typically high-dimensional, containing thousands of gene features but relatively few patient samples, which pose challenges for traditional machine learning approaches, making them sensitive to noise and prone to overfitting. In this study, we introduce a novel preprocessing framework based on fractional calculus to enhance the analysis of gene expression profiles. By applying fractional derivatives to the gene

expression vectors, subtle variations and long-range dependencies among genes can be captured, revealing complex correlations that conventional integer-order methods often miss. This transformation effectively enhances the separability of malignant and benign profiles, providing more informative and robust features for subsequent classification models. Preliminary evaluations indicate that the fractional feature transformation improves overall classification accuracy while mitigating the dimensionality burden and noise sensitivity inherent in high-dimensional genomic data. Beyond improving predictive performance, this approach bridges mathematical innovation with practical biomedical applications, demonstrating the potential of fractional calculus to uncover hidden patterns in complex biological datasets. By integrating advanced mathematical techniques with real- world cancer diagnostics, the proposed methodology offers a promising avenue for precision oncology, enabling more reliable and interpretable gene expression-based classification. This work highlights the value of combining interdisciplinary approach mathematics, computer science, and biomedical science—to address pressing challenges in modern healthcare and underscores the potential of fractional methods in transforming biological data analysis.

Keywords: Gene expression, fractional derivative, feature preprocessing, data analysis, cancer classification

STAT-1828: Predictive Modeling by Using Integrative Machine Learning Algorithms for Healthcare Data

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This study investigates the predictive performance of ten machine learning algorithms for diabetes detection using two distinct datasets: one from the United States and another from Pakistan. The models are evaluated using key performance metrics, including Accuracy, Precision, Recall, F1 Score, AUC, and Specificity. Ensemble-based models such as Random Forest, XGBoost, and AdaBoost demonstrated exceptional performance on the Pakistani dataset, achieving near-perfect AUC values and accuracies exceeding 99\%, indicating strong reliability. However, their performance declined significantly on the U.S. dataset, where the Neural Network achieved the highest accuracy of 75.25\%. This disparity underscores the importance of regional data characteristics and suggests that predictive healthcare models must be tailored to specific population contexts. Overall, the findings emphasize that region-specific training data and customized model selection are critical for enhancing prediction accuracy in clinical applications.

Keywords: Predictive modeling, Machine learning, Pakistani diabetes dataset, USA diabetes dataset, BRFSS

STAT-1853: Innovative Approach to Minimize Misclassification Error in Binary Output using Ensemble Methods

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Every single minute, enormous amounts of data is produced, due to the rapid advancement and extensive use of technology. However, managing and analyzing this data has become more difficult, particularly when there are more features than observations in high-dimensional situations. Classifier performance in supervised machine learning problems may significantly be affected by this high dimensionality. Ensemble learning, a popular machine learning technique, emerged as an effective solution for this particular issue. ENet, SVM, NN are the three base learners that are used in this proposed ensemble framework. This ensemble reduces the misclassification error and also enhancing robustness as compared to other classifier. The proposed method selects predictions based on maximum True Positive Rate (TPR) of the base classifier. In order to aggregate the predictions of the various classifiers, majority voting is used. We analyzed our ensemble's performance (called ETP) on simulated datasets and microarray datasets. The ETP constantly achieves minimum misclassification error rates on simulated datasets and microarray datasets which indicate that it perform better as compared to other well-known classifiers, such as RF, KNN, AdaBoost and the baseline classifiers that were used to build it.

Keywords: Machine Learning, Ensemble Learning, Classification, High-dimension data, True Positive Rate

STAT-2004: Predicting Term Deposit Subscription using Machine Learning Techniques: A Comparative Analysis of Classification Models for Prediction

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Direct bank marketing campaigns often face low success rates, as only a small fraction of clients subscribe to term deposits. Traditional methods fail to capture the nonlinear patterns that influence customer behavior. This study used the Portuguese Bank Marketing dataset with 41,188 records (20 independent features and one target variable) to apply machine learning techniques for improving prediction accuracy and providing insights for more efficient campaigns. Preprocessing included handling missing values, detecting outliers, and balancing the target class with SMOTE, while exploratory analysis showed that middle-aged and educated clients, longer call durations, and favorable economic conditions increased subscription likelihood, whereas excessive contacts reduced effectiveness. Four supervised learning models—Random Forest, XGBoost, Decision Tree, and Logistic Regression—were evaluated using accuracy, precision, recall, F1-score, and Cohen's Kappa. Random Forest achieved the best

performance with 91.42% accuracy and balanced recall and precision. XGBoost followed closely with 91.0% accuracy and the strongest precision (57.77%), though recall was weaker. Decision Tree achieved 88.75% accuracy with the highest recall (88.39%) but suffered from poor precision and overfitting. Logistic Regression performed the weakest, with 86.13% accuracy, serving as a baseline. The findings show that ensemble methods, particularly Random Forest and XGBoost, provide the most reliable predictions for term deposit subscription. By integrating preprocessing, exploratory analysis, model comparison, and feature evaluation, this research adds methodological, theoretical, and practical value. The results suggest that banks can improve targeting, reduce wasted efforts, and design more cost-effective marketing stsrategies using advanced machine learning models.

Keywords: Machine Learning, Bank Marketing, Term Deposit, Predictive Analytics, Classification Models

STAT-2007: Comparative Analysis of Machine Learning Models for Real Life Data

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This study presents a comparative analysis of multiple machine learning (ML) models include Decision Tree, K-Nearest Neighbors (KNN), Naïve Bayes, Logistic Regression, Support Vector Machine (SVM), Random Forest, and Gradient Boosting applied to real-world forest health data. Comprehensive preprocessing techniques such as normalization and standardization were applied, and models were evaluated using key performance indicators including accuracy, precision, sensitivity, F1-score, and specificity. Initial results showed that ensemble models like Random Forest and Gradient Boosting provided the highest accuracy among the models tested. However, after hyper parameter tuning, SVM emerged as the most effective model with near-perfect scores across all metrics, achieving an accuracy of 99.78%. The study highlights the significance of parameter optimization in improving model performance and reinforces the potential of machine learning in ecological monitoring. These findings suggest that ML models, especially ensemble and kernel-based techniques, can provide scalable, accurate, and timely solutions for forest health assessment and decision-making in conservation efforts.

Keywords: Forest Health, Machine Learning, Classification Models, Decision Tree, Random Forest, Support Vector Machine, K-Nearest Neighbors, Logistic Regression, Gradient Boosting, Naïve Bayes, Hyper parameter Tuning, Environmental Monitoring, Predictive Modeling, Model Evaluation

STAT-2006: Classification and Forecasting of E-Commerce Orders in Pakistan using Machine Learning Techniques

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This study examines the classification and forecasting of e- commerce orders in Pakistan using the Pakistan's Largest E- Commerce Dataset, with the objective of improving predictive accuracy and supporting data-driven decision-making in the digital commerce sector. For classification tasks, Random Forest and XGBoost were applied to predict binary order status (successful vs. unsuccessful). Random Forest outperformed XGBoost across all evaluation metrics, achieving 67.9% accuracy, 67.03% balanced accuracy, 54.2% sensitivity, 79.85% specificity, 70.12% precision, and an F1-score of 0.727, compared to XGBoost's 66.19% accuracy and F1-score of 0.709. Feature importance analysis revealed that grand total, price, and discount amount were the most influential predictors, underscoring the strong role of pricing strategies and promotions in determining order completion. For forecasting, ARIMA provided limited performance with a MAPE of 41.1%, while SARIMA enhanced seasonal accuracy (MAPE ≈ 21%). Prophet achieved the best forecasting accuracy (MAPE = 17.4%), effectively capturing both long-term trends and seasonal variations in sales. Taken together, the findings confirm Random Forest as the most robust model for classification, Prophet as the most effective model for forecasting, and SARIMA as a stronger alternative to ARIMA. This research contributes to Pakistan's e-commerce literature by demonstrating how advanced machine learning and time series methods can uncover key drivers of consumer behavior, highlight the importance of pricing, discounts, and seasonality, and provide actionable insights for improving customer retention, demand forecasting, and long-term digital growth.

Keywords: E-commerce, Pakistan, Machine Learning, Random Forest, XGBoost, Classification, ARIMA, SARIMA, Prophet, Forecasting, Order Status Prediction, Feature Importance, Seasonal Trends, Pricing Strategies, Customer Retention

STAT-1623: An Optimal Neutrosophic Ratio Estimator in PPS Sampling Scheme

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In various fields of life, precise estimation of a finite population's mean is required. The conventional ratio estimators can only work with precisely defined observations. These conventional estimators may give misleading results in real-life situations in which some, if not all, data points are inevitably vague, indeterminate or imprecise. Using probability proportional to size sampling, we present an enhanced neutrosophic mean estimator utilizing an ancillary variable. The suggested neutrosophic estimator has been designed to handle imprecise measurements in data sets. We assess various statistical properties of our

suggested neutrosophic estimator. Our results indicate that the new ratio estimator improves the efficiency of the competitor ratio estimators in the presence of imprecise measurements. We use real-life neutrosophic data to show the improvement under unequal probability sampling.

Keywords: Auxiliary information, efficiency, neutrosophic data, population mean, sample surveys.

STAT-1624: An Optimal Exponential Ratio Estimator Using Probability Proportional to Size Sampling

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Effective planning in the present period depends more and more on statistical methods to estimate different aspects of the populations being studied. Utilizing the amount of information obtained from sample data, we can make efficient estimations about population parameters using one or more auxiliary variables that are correlated with the study variable. In situations where each population unit is equally important, the conventional equal probability sampling designs are employed. If the population units have varying probabilities of selection, unequal probability sampling is used. In this study, an improved exponential ratio type estimator is presented under unequal probability sampling. We present some practical applications and also obtain the approximate algebraic equations for the mean square error. Out analysis suggests that our suggested estimator achieves smaller mean square error compared to its competitor estimators. Empirical comparisons between the proposed and competitor estimators are provided. Examples of real-world data are also provided to demonstrate the enhancement over the competitor estimators.

Keywords: Auxiliary Variable, Bias, Efficient Estimator, PPS Sampling, Population Mean

An Innovative Randomized Response Model for Estimation of Sensitive Information

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This thesis addresses the challenges of collecting accurate information on sensitive variables by employing randomized response technique (RRT). Conventional survey methods often suffer from non-response and misreporting, while RRT protect respondent privacy and reduce bias. In Chapter 1, the background, motivation and objectives of the study are outlined, emphasizing the need for more efficient estimators in sensitive surveys. In Chapter 2, a scrambled randomized response model is proposed by introducing correlated scrambling variables. Theoretical derivations and numerical illustration confirm that the estimator is unbiased and its variance is shown to be lower than competitor estimator. In Chapter 3, the methodology is extended to simultanous estimation

of means of two sensitive variables case. The proposed estimators are unbiased and efficency comparisons highlight their superiority over earlier models. In Chapter 4, contains the conclusion and future recommendations. Overall, the research contributes novel univariate and bivariate scrambled response models that enhance respondent confidentiality while improving efficiency of the estimators in survey methodology.

Keywords: Randomized response technique, scrambled response model, sensitive variable, estimator efficiency, variance reduction, survey methodology, simultaneous estimation

A Control Chart for Bivariate Discrete Data Monitoring

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Control charts are sophisticated graphical tools used to detect and control aberrant variations. Different control schemes are designed to continuously monitor and improve the process stability and performance. This study proposes a bivariate exponentially weighted moving average chart for joint monitoring of the mean vector of Gumbel's bivariate geometric (GBG) data. The performance of the proposed chart is compared with the Hotelling's T^2 chart. The results of the study indicated that the proposed control chart performs uniformly and substantially better than the Hotelling's T^2 chart. In addition to two real-life examples, an example based on simulated data is also considered and compared to existing charts to verify the superiority of the proposed chart. Based on the comparisons, it turns out that the MEWMA (GBG) chart outperforms the Hotelling's T^2 chart and paired individual EWMA control chart.

Keywords: Average run length; bivariate Gumbel distribution; Basu– Dhar distribution; control chart; exponentially weighted moving average

Effects of Sleep Quality on Mental Work Load among Nurses in Public Sector Hospital's Bahawalnagar

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This study examines the relationship between sleep quality and mental workload among nurses working in public sector hospitals in Bahawalnagar, Pakistan. Nurses, particularly those working in high-pressure environments like public hospitals, often experience poor sleep quality due to long shifts and high demands, which can impair cognitive performance and increase mental workload. This quantitative, cross-sectional study involved 235 nurses from District Headquarter and Tehsil Headquarter Hospitals, using the Pittsburgh Sleep Quality Index (PSQI) and NASA Task Load Index (NASA- TLX) to assess sleep quality and mental workload, respectively. The study found that 66.8% of nurses reported poor sleep quality, with a significant positive correlation ($\rho = 0.696$, $p = 0.026$) between poor sleep and higher mental workload. Demographic factors such as

age, marital status, and chronic diseases were significant contributors to mental workload. The results indicate that poor sleep quality leads to higher levels of mental workload, which can impact job performance and patient safety. This research underscores the need for targeted interventions, including better shift scheduling and stress management strategies, to improve nurse well-being and reduce cognitive fatigue, ultimately enhancing job performance and patient care quality. The findings contribute to the limited body of research on sleep quality and mental workload in nurses in Pakistan, offering insights into how sleep disturbances affect healthcare professionals' mental health and work efficiency.

Keywords: Sleep Quality, Mental Workload, Nurses, Cognitive Efforts, Job Performance

Estimation of Population Mean Using Supplementary Variable

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In this study, a class of exponential ratio-type estimators is proposed for the estimation of the population mean under simple random sampling without replacement. These estimators are specifically designed to enhance estimation efficiency by incorporating supplementary information from both continuous and categorical variables. The effective utilization of such information plays a significant role in improving the precision of estimates for finite population parameters, including the mean, proportion, total, and variance. To establish their theoretical properties, expressions for the bias and mean squared error (MSE) are derived up to the first order of approximation. In order to assess their empirical performance, a comprehensive numerical analysis is conducted using five real-world datasets, with results compared against several well-established estimators. Following this, the proposed class of exponential ratio- type estimators for the estimation of the population mean under simple random sampling without replacement is presented in detail, including theoretical derivations and properties. Finally, the study concludes by summarizing the key findings, emphasizing the superiority of the proposed estimators in terms of efficiency, and offering recommendations for future research and practical applications.

Keywords: Population Mean Estimation, Exponential Ratio-Type Estimators, Simple Random Sampling, Stratified Random Sampling, Auxiliary Information, Mean Squared Error (MSE)

STAT-1888: Investigating the Impact of Mobile Phone Usage on Academic Performance among University Students

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This study examines the relationship between university students' academic performance and mobile phone addiction. In addition to this some other demographic factors such as age, department, and socioeconomic position were also analyzed. A structured questionnaire was used to gather data for a quantitative study design, and correlation analysis, chi-square tests, and descriptive statistics were used for analysis. According to the findings, a sizable percentage of students describe themselves as moderately or severely dependent on their phones, and there is a clear inverse relationship between academic achievement and mobile phone use. Chi-square tests confirmed statistically significant relationships between academic performance and variables including department and socioeconomic background, as well as between academic satisfaction and mobile phone addiction. The results imply that excessive and uncontrolled usage of mobile phone may result in lower academic performance and dissatisfaction. However, some students maintain excellent academic outcomes despite the use of regular mobile. These findings highlight the necessity of awareness campaigns and digital wellness initiatives in educational establishments to encourage better mobile phone use and aid in students' academic achievement.

Keywords: Learning skills, Academic performance, Mobile phones, University students

ZOOLOGY

ZOO-1523: Herbal Modulation of Growth and Immune Responses in *Labeo rohita* Against *Aeromonas hydrophila*

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An experimental study was conducted to evaluate the effects of *Achyranthes aspera* and *Ricinus communis* seed extracts on the growth performance and immune response of *Labeo rohita*. One hundred twenty fish (initial weight 6.50±0.004g) were purchased from local hatchery in Punjab and acclimatized under laboratory conditions on a control diet for one week. Ethanol extracts of plant seeds were prepared and incorporated into the basal diet. The fish were randomly assigned to six aquaria (20 fish per aquarium) with replicates and fed at 4% of their body weight twice daily for 60 days. Treatments included a control group (T0) and two experimental groups: T1: MP1 (basal diet + 2 g *A. aspera* seed extract) and T2:MP2 (basal diet + 2 g *R. communis* seed extract). Water quality

parameters were maintained throughout the trial. The results showed that fish in T1 group exhibited the highest growth rate and weight gain ($p < 0.05$), followed by fish in the T2 group. Both T1 and T2 groups demonstrated significantly elevated serum IgM levels compared to the control ($p < 0.05$). *A. hydrophila* was cultured in tryptic soy broth (TSB) to prepare the bacterial challenge inoculum used for assessing disease resistance in *L. rohita*. After 60 days, ten fish from each group were challenged with live *A. hydrophila* and observed for 10 days. Cumulative survival was highest in T1, intermediate in T2, and lowest in the control. The control group also displayed the highest mortality rate with evident clinical signs of bacterial infection. These findings indicate that seed extracts of *A. aspera* and *R. communis* enhance growth and immune response in *L. rohita* and may serve as natural alternatives to antibiotics. It is concluded that these herbal extracts are effective for treating fish diseases, reducing drug resistance, and minimizing residual drug accumulation in fish and consumers.

Keywords: Achyranthes aspera, Ricinus communis, Labeo rohita, growth, immunity

ZOO-1524: Impact of Herbal Seed Extracts on Blood Profile and Histology of *Labeo rohita*

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The study investigated the effect of seed extract of *Achyranthes aspera* and *Ricinus communis* on hematology and histology in *Labeo rohita*. 120 fish (6.5g±0.001) were acclimatized in aquaria for one week with a control diet (32% CP). Ethanolic extract of seeds of medicinal plants was prepared. One control and two treatment diets T1:MPSE1 containing *A. aspera* and T2:MPSE2 containing *R. communis* extracts were prepared. Fish were stocked in respective aquaria with replicates (20 fish/aquaria) under a completely randomized design. The fish were fed at a rate of 4% of their body weight administered twice daily for a period of 60 days. Water quality parameters were monitored throughout the trial. At the end of the trial, hematological parameters and histology of liver were analyzed. Hematological analysis revealed a significant ($P<0.05$) increase in RBC count, hemoglobin and hematocrit levels in T1, showing *A. aspera* boosts immunity. The findings demonstrated that the inclusion of *A. aspera* extract in fish feed significantly ($P<0.05$) improved hematological parameters and liver histo-architecture, indicating enhanced physiological health and better systemic responses in fish. It was concluded that herbal extracts improve hematological parameters and liver tissue structure. As natural, biodegradable, and economical immunostimulants, medicinal plants offer a sustainable approach to enhancing fish health.

Keywords: Labeo rohita, Achyranthes aspera, Ricinus communis, hematological indices, growth performance.

ZOO-1683: A cross sectional study on the incidence and risk factors of diabetes mellitus among population of Rawalakot, Azad Jamu and Kashmir

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Diabetes mellitus (DM) is a chronic, long-term disease causing consistently elevated blood glucose levels due to inadequate insulin production, targeting people of all ages, genders, and geographical areas worldwide. DM raises the incidence of sensorineural hearing loss (SNHL) in adult population. The present cross-sectional and observational study focused on the prevalence of DM, its impact on hearing ability, complications, and risk factors that contribute to the chronic condition of DM across the population of City Rawalakot, Azad Jamu & Kashmir. The status of DM and hearing ability was evaluated using a combination of HbA1c and pure tone audiometry (PTA) test, respectively, while data on the risk factors and complications were collected via questionnaire. Results of the present study suggested that out of 200 individuals, 60% were diabetic and 40% were non diabetic individuals. The study found a significant trend in DM prevalence as people age, with females having a higher prevalence (55%) compared to males (45%). Diabetes is strongly associated with SNHL, with a highly significant P-value (< 0.001). Severe hearing loss is prevalent in both genders, with females having a higher prevalence rate (56%) compared to males (51%). Prolonged diabetic duration (>9 years) and poor glycemic control (HbA1c>8) adversely affected the hearing ability. DM is strongly linked (P> 0.05) to various health- related complications, including retinopathy, nephropathy urinarytract infections. Moreover, hypertension, anxiety, stress, and a sedentary lifestyle are significant risk factors for DM.

Keywords: Sensorineural hearing loss, diabetes mellitus, HbA1c, PTA, risk factors, complications.

ZOO-1686: Effect of Cortisol in Hypertensive Patients from Haripur, Khyber Pakhtunkhwa

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The most frequent predictor of cardiovascular disease and sudden death worldwide is high blood pressure. The steroid hormone cortisol is produced by the adrenal gland. Stress is one of the primary causes of high blood pressure. Cortisol levels rise in response to stress, which causes the heart to beat more quickly and raises blood pressure. There was not enough information available regarding how cortisol contributed to hypertension in the male and female populations of Haripur, Khyber Pakhtunkhwa. Therefore, the purpose of the current study was to examine how cortisol contributes to the development of

hypertension and how increased salt intake affects cortisol levels in patients from Haripur, Khyber Pakhtunkhwa. Data about lifestyle factors, including physical activity, food, stress, and medication use, was gathered using a comprehensive survey. ELISA was used to measure the levels of cortisol in the serum. Factors associated with hypertension showed a high and statistically significant link, according to the independent samples correlations. The mean systolic and diastolic blood pressure of healthy people was 130/90 mmHg, while the mean systolic and diastolic blood pressure of hypertension patients was 140/90 mmHg. The amount of salt consumed by hypertension patients (1.17 ± 1.35, $p \leq 0.001$) and healthy people (2.48 ± 0.640, $p \leq 0.001$) differed in a highly statistically significant way. A one-way ANOVA revealed a highly significant difference between the mean value of high cortisol levels (435.29 ± 90.306, $p \leq 0.001$) and the high serum cortisol levels of hypertension patients (236.03 ng/ml-558.96 ng/ml). Similarly, hypertensive individuals' normal blood cortisol levels (118.0 ng/ml–229 ng/ml) varied significantly, with a mean value of 208.90 ± 39.210, $p \leq 0.001$. Hypertensive individuals with low cortisol levels showed extremely significant differences (11.72 ng/ml- 87.62 ng/ml), with a mean value of 93.992 ± 72.333, $p \leq 0.001$. According to the current study, women with high blood pressure have higher serum cortisol levels than men do, and roughly 28% of those with elevated serum cortisol levels reported experiencing stress on a daily basis. Thirty percent of the hypertensive participants in ourstudy consumed one gram of salt, eight percent consumed two grams, and two percent consumed three grams. Three grams of salt were ingested daily by hypertensive individuals prior to their diagnosis. People with higher dietary salt intake are more likely to develop hypertension. The current investigation came to the conclusion that cortisol levels and high blood pressure were strongly correlated. According to this study, those who consume more salt in their diet are more likely to acquire hypertension since salt has a direct impact on blood pressure.

Keywords: Cortisol, Hypertension, Salt, Serum Cortisol, Stress

ZOO-1688: An Integrative Study to Explore the Role of Environmental and Life Style Factors Influencing Hypothyroidism and Hashimoto's thyroiditis

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Hypothyroidism and Hashimoto's thyroiditis are of significant public health concern because of how common they are and the impact they have on people's lives. Hashimoto's thyroiditis, an autoimmune disease, causes long term inflammation of the thyroid gland, leading to thyroid problems and often developing into hypothyroidism. This is a cross-sectional study to explore the correlation between environmental risk factors such as pollutants, toxins, exposure to radiation, endocrine disruptors, water and soil contamination with heavy metals cadmium (Cd) and lead (Pb) and lifestyle factors such as diet, physical activity, stress, iodine uptake, smoking, and alcohol consumption with

hypothyroidism and Hashimoto's. Samples of 100 patients, ranging in age from 18 to 50 years, were collected. Demographic data including body weight, gender, height, and body mass index (BMI) blood pressure were collected through a comprehensive questionnaire. Hormonal analysis showed that levels of TSH (8.10 ± 2.10 µIU/m) was significantly (p<0.001***) higher in patients compared to the control group (2.01 ±0.54 µIU/mL), fT3 (2.21 ± 0.40 ng/mL) was significantly (p<0.001***) lower in patients then in controls (3.22 ± 0.32 ng/mL), fT4 (0.60 ± 0.14 pg/mL) was also significantly lower (p <0.001***) inpatients compared to the control group (1.10 ± 0.18 pg/mL). This study found that thyroid dysfunction was significantly associated with vitamin D deficiency (OR=2.269, p <0.0001***), high iodine intake (OR=1.570, p-value <0.0001***), artificial sweetener use (OR=1.604, p <0.0001***), physical inactivity (OR=0.693, p <0.0001***), fatigue (OR=1.177, p <0.0001***), and female gender (OR=0.94, p 0.005**). Although cadmium exposure was highly prevalent among patients, it did not emerge as an independent predictor, suggesting its effect may be influenced by coexisting lifestyle or demographic factors. An important finding was that individuals exposed to cadmium who were physically active still showed higher rates of thyroid dysfunction (p 0.049*), indicating that toxic exposure may outweigh the benefits of exercise. This study concludes that sedentary lifestyles, unhealthy dietary habits, and environmental contaminants all contribute to thyroid disease. To lower modifiable risk factors, public health measures should place a high priority on routine screening, environmental regulation, and health education.

Keywords: hypothyroidism, Hashimoto's thyroiditis, endocrine disruptors, BMI, Pb

ZOO-1689: Remedy of Fipronil-Induced Hepatoxicity with Ascorbic Acid and Silver Nanoparticles in Chicken

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The current study aimed to investigate the toxic effects of Pyrazole and Fipronil on liver function in developing chicks, and the protective effects of Ascorbic acid and Silver nanoparticles. Chicks measuring 20-30g, aged 2-3 days, were collected from the hatchery and separated into nine groups. Doses were administered orally every day for four weeks. Group I was control group treated with 0.9% NaCl. Group II was administered Pyrazole (25 mg/kg b.w.). Group III was given 20 µl of silvernanoparticles (AgNP) each animal. Group IV was administered Pyrazole (25 mg/kg b.w.) and Ascorbic acid (250 mg/kg b.w). Group V received Ascorbic acid (250 mg/kg b.w). Group VI received Fipronil (4.5 mg/kg b.w.). Group VII received Fipronil (4.5 mg/kg body weight) and Ascorbic acid (250 mg/kg body weight). Group VIII was administered with AgNP (20 µl/animal) and fipronil (4.5 mg/kg body weight). Group IX received AgNP (20 µl/animal) and pyrazole (25 mg/kg b.w). Animals underwent dissection after the last dose administration and

blood was collected for liver function assays including ALT, AST, and ALP. Results showed that Pyrazole treated group had slightly higher body weight ($p<0.0001$) in the 4 weeks-time of treatment, whereas Fipronil group exhibited considerably lower weight gain ($p<0.05$). ALT, AST, and ALP levels were significantly increased ($p<0.0001$) in the Pyrazole and Fipronil exposed groups. Treatment with Ascorbic acid ($p<0.0001$) and silver nanoparticles ($p<0.05$) resulted in better weight gain and enzyme levels were comparable to the control. There was a substantial link between enzyme elevation and weight suppression. The study found that Pyrazole and Fipronil produced hepatotoxicity in chicks, but Ascorbic acid and Silver nanoparticles reduced liver toxicity.

Keywords: Fipronil, ALT, AST, ALP, Silver nanoparticles, Hepatotoxicity

ZOO-1691: Study on the Prevalence and Risk Factors Causing Urinary Tract Infections (UTIs) in Diabetes Mellitus Patients from Peshawar, Khyber Pakhtunkhwa

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In recent years, diabetes mellitus (DM) has been emerged as a major health concern. Pakistan ranks seventh the greatest proportion of diabetic patients. Diabetes altered the host immune system and excessive amount of glucose inside the urine provides good nourishment during the growth of bacteria, which makes DM patients more susceptible for urinary tract infections (UTIs). Up till now, to our best knowledge, information regarding the incidence and risk variables for UTIs in DM individuals in Peshawar is very scarce. Therefore, the objectives of this research aimed to evaluate the frequency of UTIs in diabetic participants, assess risk factors that cause UTIs in DM patients, and identify the pathogens present in the urine of non-diabetic subjects and diabetic UTIs patients in Peshawar, Khyber Pakhtunkhwa. This cross-sectional research had been carried out at Lady Reading Hospital Medical Teaching Institution (LRH-MTI) Peshawar. A total of 200 participants including both diabetic (n =100) and non-diabetic (n =100) control people were included in this study. A questionnaire was utilized to collect patient's detail about socio-demographics as well as risk parameters. Clean midstream urine sample was taken from each participant. Cystine Lactose Electrolyte Deficient (CLED) and MacConkey agar were used for a purpose of medium for urine culture. Samples of urine had been inoculated onto CLED and MacConkey agar plates. Each Pathogen was further identified through Gram staining and biochemical test. UTIs ratio in DM participants was 34% but in non-diabetic was 21%. DM patients having diabetes for more than ten years or patients with earlier UTIs experiences were important risky variables that link with the development of UTIs. Pathogens separated from diabetic as well as non-diabetic urine were *Escherichia coli* and *Klebsiella pneumoniae*. However, *Pseudomonas aeruginosa* were isolated only from the urine of individuals with diabetes. Occurrence of UTIs was found 34% in diabetic participants than those of non-

diabetics. This study concluded that prior exposure with UTIs along with diabetes has a long duration were the essential risk variables that cause UTIs in DM patients.

Keywords: DM, UTIs, risk factors, prevalence, Peshawar

ZOO-1694: Study of Antimicrobial Effects of Different Honey Types on Selected Bacterial Species Againts Selected Antibiotics

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This study aimed to evaluate the antibacterial activity of Eucalyptus, *Citrus*, and *Sider* honey against *Staphylococcus aureus* and *Escherichia coli*, to determine minimum inhibitory concentration (MIC) and synergistic effects of honey and antibiotics. Honey samples were collected directly from beekeepers. The molecularly identified Gram-negative *E. coli* and Gram-positive *S. aureus* bacterial strains used in this study were acquired from the lab of the National University of Medical Sciences (NUMS), Rawalpindi. Assessment of antimicrobial activity of honey was done by agar well diffusion method, determination of pH and electrical potential of honey, and minimum inhibitory concentration (MIC) were also done. The evaluation of the synergistic effect of various honey concentrations with the antibiotic, Augmentin (Amoxicillin/clavulanic acid 20/10µg), was performed. The study revealed that the selected honey types shown inhibition zones against both selected strains. The zone of inhibition values of gram-positive bacteria were significantly higher than those of gram-negative bacteria, indicating that the former were more vulnerable to all investigated honey types. The disc diffusion method demonstrated the remarkable synergistic effects of antibiotic (Augmentin) with all honey types against *S. aureus* at 50%, 75% and 100% of honey concentrations, however it did not exhibit any synergistic effects with all honey types except with Citrus honey at 75% concentration against *E. coli*. The conclusion is that the Sider, *Citrus* and *Eucalyptus* honey possesses remarkable antimicrobial activity against both pathogenic bacteria; *S. aureus* and (anti-biotic resistant) *E. coli*. However, the *Eucalyptus* honey showed the maximum antibacterial activity than the other two honey types.

Keywords: Eucalyptus, Citrus, Sider, Staphylococcus aureus, Escherichia coli, Augmentin, Minimum inhibitory concentration (MIC).

ZOO-1750: Assessment of Blood-Based Hematological Parameters in Breast Cancer Patients

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The breast cancer is the most prevalent among women worldwide, represents 25% of all malignancies in women with high mortality rate and changes in hematological parameters could be significant predictors toward treatments, and

the course of the disease. The purpose of this study was to compare the alterations of hematological parameters in patients with breast cancer to that of healthy controls. In addition to complete blood counts, several related indices were analyzed, including hemoglobin, hematocrit, red blood cells, white blood cells, platelet indices, differential leukocyte counts, and others with automated hematological analyzer system. The results displayed notable significant differences in the parameters such as hemoglobin, hematocrit, platelet, RWD and other factors such as monocytes and basophiles indicators. Changes in the indices of platelet count and platelet volume indicated increased platelet activation, which could aid in the spread and metastasis of tumors. Increased neutrophil counts were noted, suggesting a systemic inflammatory response and compromised immunological control. Additionally, differences in hemoglobin levels indicate anemia and metabolic imbalance. Non- significant results were also observed in APTT, MCV, MCH, lymphocytes, and eosinophiles. According to these findings, routine hematological measures may be accessible, affordable markers to supplement clinical evaluation and diagnosis in patients with breast cancer.

Keywords: breast cancer, hematological parameters, predictive treatment, tumor progression

ZOO-1752: A Case-Control Study to Report the Association of the Presence or Absence of *GSTM1* and *GSTT1* with the Incidence of End Stage Renal Disease in the Subjects Enrolled from Multan District

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End-stage renal disease (ESRD) is a serious health problem that represents permanent loss of kidney function and requires dialysis or transplantation. Chronic kidney disease (CKD) is the most common cause of ESRD and develops through both genetic and environmental factors. Among genetic risks, deletions in Glutathione S-Transferase (GST) genes, especially GSTM1 and GSTT1, are thought to increase oxidative stress and make individuals more vulnerable to kidney damage. This case-control study was conducted to investigate the association of GSTM1 and GSTT1 null genotypes with ESRD in the population of Multan District, Pakistan. A total of 154 confirmed ESRD patients from the Nephrology and Dialysis Ward of Nishtar Medical Hospital, Multan, and 154 healthy controls matched for age and sex were included. DNA was extracted from blood samples and analyzed through multiplex PCR using CYP1A1 as an internal control. Clinical and lifestyle data, including smoking, hypertension, diabetes, and biochemical parameters, were also recorded. The GSTM1-null genotype was found in 62% of patients compared to 38% of controls, while the GSTT1-null genotype occurred in 54% of patients compared to 32% of controls ($p < 0.05$). The presence of both null genotypes further increased the risk of ESRD (OR = 3.5; 95% CI: 2.2–5.8). These deletions were linked with higher oxidative stress markers and weaker antioxidant defenses. Risk was further increased in patients

with smoking, diabetes, or hypertension. In conclusion, GSTM1 and GSTT1 deletions are significantly associated with ESRD in the local population. Genetic screening together with early lifestyle and nutritional interventions may help in reducing the burden of ESRD in Pakistan.

Keywords: End-stage renal disease, GSTM1, GSTT1, Genetic polymorphism, Case-control study, Multan District

ZOO-1756: Assessment of Adulticidal and Larvicidal Effect of *Trachyspermum ammi* Against *Hyalomma anatolicum*

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In Pakistan, ticks present a major threat to both livestock and humans, as they can transmit a variety of infections, including those caused by protozoa, viruses, and bacteria such as spirochetes and rickettsiae. Although different chemical acaricides have been used to combat ticks, many tick species have developed resistance to these commercially available drugs. This study evaluated the acaricidal effectiveness of methanolic extract from the *Trachyspermum ammi* plant against ticks at various stages using the adult immersion test (AIT) and the larval packet test (LPT), comparing the results with the positive control, amitraz. The methanolic extract was tested for its acaricidal activity at different time intervals and concentrations of 5 mg/ml, 10 mg/ml, 15 mg/ml, and 20 mg/ml. Both AIT and LPT used the same concentrations. The extract showed a 94% mortality rate in the AIT bioassay and a 99% mortality rate in the LPT bioassay. Distilled water and amitraz served as the negative and positive controls, respectively. At a 24-hour exposure and the highest concentration of 20 mg/ml, the *Trachyspermum ammi* extract resulted in significant mortality rates of 91% for adult ticks and 90% for larvae, comparable to the 90% mortality caused by amitraz, indicating no significant difference from the positive control. Furthermore, the methanolic extract of *Trachyspermum ammi* significantly inhibited tick egg-laying ability, with inhibition rates increasing from 20.826% to 85.949% as the extract concentration increased from 5 mg/ml to 20 mg/ml. This study aimed to identify an environmentally friendly acaricide and evaluate the effectiveness of *Trachyspermum ammi* plant extracts on ticks at different developmental stages. The results suggest that this plant could be a viable alternative to commercially available acaricides.

Keywords: Ticks, Tick-borne diseases, Trachyspermum ammi, Acaricidal activity, Methanolic extract, Mortality, Oviposition inhibition, Amitraz

ZOO-1759: Proximate Composition of Muscle Tissue of *Labeo Rohita* with Respect to Body Weight and Habitat

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Labeo rohita is one of the most widely consumed freshwater carps in South Asia, known for its fast growth, economic importance, and nutritional richness. As a major aquaculture species, it plays a vital role in meeting regional protein demands, making the evaluation of its proximate composition under different environmental and biological conditions essential. The present study investigated the effects of habitat and body weight on the proximate composition of *L. rohita*. For this purpose, fish samples were collected from both farm and river habitats and categorized into two weight groups (1–2 kg and >2 kg). Standard Association of Official Analytical Chemists (AOAC) procedures were followed: moisture and dry matter were determined by oven-drying, ash by muffle furnace incineration, crude protein by the Kjeldahl method, and crude fat by Soxhlet extraction. Results of the present study suggested that *L. rohita* with >2 kg body weight had significantly higher dry matter and moisture contents compared to smaller fish (1–2 kg). Farm-raised specimens exhibited significantly higher dry matter content, while river-raised fish consistently showed greater moisture levels. Ash content was significantly higher in riverine fish with >2 kg body weight compared to farm-raised fish of the same body weight. Protein content was markedly greater in riverine fish than farm-raised fish of same body weight, whereas protein levels were higher in smaller (1–2 kg) fish compared to larger (>2 kg) fish with the same habitat. In conclusion, the proximate composition of *L. rohita* was affected by both habitat and body weight. Riverine habitats promoted higher protein, ash, and moisture content, while farm environments favored greater dry matter accumulation. These findings highlighted that natural habitats improve the nutritional quality of *L. rohita*, whereas aquaculture conditions alter nutrient balance, particularly in terms of dry matter and fat deposition.

Keywords: Labeo rohita, proximate analysis, Kjeldahl method, Soxhlet extraction, aquaculture nutrition, habitat variation, fish body weight, muscle composition

A Brief overview: Prevalence of Different Diseases in Birds (Pheasants) in Captivity in District Peshawar

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Pheasants, members of the Phasianidae family, are widely distributed globally and serve as an important food source in various countries, including Pakistan. Newcastle Disease (ND), a highly contagious viral infection caused by avian paramyxovirus, poses a significant threat to pheasant populations. The present study investigated an outbreak of ND among pheasants housed at Peshawar Zoo,

focusing on two species: the Ring-necked Pheasant (*Phasianus colchicus*) and the Wood Green Pheasant. Data were collected from January to March 2022 through structured questionnaires and daily clinical monitoring during the course of infection and recovery. A total of 34 pheasants were affected—13 Ring-necked and 21 Wood Green. Among the Ring-necked pheasants, five (3 males, 2 females) succumbed to the disease, while eight recovered. In the Wood Green group, three deaths (2 males, 1 female) were recorded, with 18 birds recovering. Mortality was notably higher in males across both species. Common clinical signs included significant reductions in feed intake (40–90%), weight loss (8–16%), and decreased egg production in laying hens. These findings highlight the impact of ND on pheasant health and productivity, and underscore the importance of timely diagnosis, monitoring, and management strategies in captive avian populations.

Keywords: Newcastle Disease, Poultry, Pakistan, Pheasant, Paramyxovirus, Avian Health

Estimation of Toxic Heavy Metals in Rohu (*Labeo rohita*) from the Dams of Northern Punjab, Pakistan

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This study aimed to estimate the concentrations of toxic heavy metals including Mercury (Hg), Lead (Pb), and Cadmium (Cd) in Rohu (*Labeo rohita*) collected from two dams of Northern Punjab, Pakistan, including Mujahid Dam (Tehsil Rawalpindi) and Dhok Sunday Mar Dam (Tehsil Taxila). Fish muscle tissues were analyzed using Atomic Absorption Spectroscopy (AAS) following standardized protocols to assess contamination levels. Among heavy metals, Mercury consistently detected in both dams (in safe limits), while Lead and Cadmium exceeded the safe limits in Mujahid Dam. The findings highlight that Mercury is the most detected contaminant across both water bodies, but within safe limits, while the concentrations of Lead and Cadmium was detectable in all samples of Mujahid Dam, and exceeded the safe limits. These results underscore the importance of monitoring Mercury, Lead and Cadmium in local water bodies of District Rawalpindi Northern Punjab, Pakistan and emphasize the need for further investigations into the sources and impacts of heavy metal contamination in aquatic environments.

Keywords: heavy metals, Labeo rohita, atomic absorption spectroscopy, bioaccumulation, water pollution, Pakistan

ZOO-1778: Population Dynamics, Structure, Survival and Sustainable Growth of Golden Mahseer (*Tor putitora*) of River Jehlum, Tehsil Kahuta at Karot Hydropower Project

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The Golden Mahseer (*Tor putitora*), an iconic, migratory and ecologically significant freshwater species native to the Jhelum River, is increasingly threatened by habitat degradation and anthropogenic pressures near the Karot Hydropower Project. A comprehensive field-based ichthyofaunal assessment was conducted, along the Jhelum River.The research focused on species dominance and ecological patterns across ten strategically selected sites, including five tributary naalas, two upstream, and three downstream locations. Standardized fish sampling was performed monthly using a combination of cast nets, gill nets, drag nets, and electrofishing to ensure complete species representation. All collected specimens were preserved, counted, and identified to species level using standard taxonomic keys and relevant literature. A total of 39 fish species belonging to 4 orders, 11 families, and 25 genera were documented from the selected sites of the study area. Cyprinidae was the most dominant family represented by 12 species, followed by Nemacheilidae (7 species) and Sisoridae (3 species). Species diversity was higher in upstream zones with loaches and small cyprinids, whereas downstream sites were dominated by snow trout and mahseer, showing clear spatial and seasonal distribution patterns. Notably, *Tor putitora*, a key indicator species for riverine health, exhibited varying dominance across the study sites, with significant declines in areas influenced by anthropogenic pressures. This study provides baseline information for fisheries management and conservation planning in the river system, highlighting the importance of protecting dominant and ecologically valuable species. Moreover, the findings suggest that future research should focus on habitat restoration and monitoring of population trends under increasing anthropogenic pressures and climate variability.

Keywords: Golden Mahseer, Karot Hydropower Project, Population dynamics, Conservation, Freshwater fish, Kahuta

ZOO-1786: Serum Uric Acid as a Prognostic Marker among Patients with Cardiovascular Disease in the Islamabad Capital Territory

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The catabolic byproduct of human purine, uric acid, is linked to hyperuricemia and cardiovascular events. It is broken down by the uricase enzyme, which was absent in apes and humans ancestors approximately 15 million years ago. The purpose of the current study is to check the association of blood uric acid levels of

myocardial infarction (MI) patients to those of controls. The present investigation was carried out in Islamabad Capital Territory. The study was conducted on 83 individuals, 40 age-matched controls, 43 individuals were diagnosed with MI. Uric acid levels, risk factors, medical history, age, and ethnicity are all taken into consideration when gathering data. In the hospital laboratory, a chemical analyzer was used to perform a uric acid test. Employing an in vitro test to determine the level of uric acid in human blood serum. Serum uric acid has a cutoff value >7.2. Hyperuricemia and MI were found to be significantly correlated. Based on the findings of our study, a raised level of serum uric acid is associated with adverse cardiovascular outcomes.

Keywords: serum uric acid, myocardial infarction, hyperuricemia, cardiovascular disease

ZOO-1797: Impact of Subacute Hyperglycemia on the Testis in Wistar Rats Supplemented with or Without Zinc.

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Diabetes mellitus, a metabolic disorder, is characterized by elevated plasma glucose levels, known as hyperglycemia. Diabetes mellitus is caused by a lack of sufficient insulin secretion during periods of high demand and/or defective cellular insulin signaling. Abnormally high levels of glucose inside the cells cause oxidative stress and generate reactive oxygen species (ROS). Reactive oxygen species negatively affect the reproductive capacity in otherwise fertile men, causing infertility. Testosterone-producing interstitial Leydig cells are particularly impacted by hyperglycemia, as these cells are present outside the blood-testis barrier and exposed to circulating high levels of glucose. Testosterone initiates and maintains the process of spermatogenesis in collaboration with Sertoli cells. In the current study, we aimed to assess the impact of hyperglycemia on testicular endocrinology and spermatogenesis in a hyperglycemic adult male rodent model supplemented with or without zinc. Elemental zinc has been shown to have strong antioxidant ability. Zinc has been shown to balance testosterone levels, thereby maintaining male fertility. The first group of animals (n=12, adult male albino Wistar rats) was pretreated with streptozotocin (STZ). The second group of animals (n=12) was supplemented with zinc before the STZ pretreatment. Body weight and blood glucose levels were monitored daily. The first group was sacrificed on the 5th day, 10th day, and 15th day post-STZ treatment. Zinc-supplemented animals were sacrificed on specific days, i.e. 20th, 25th, and 30th. 4 animals were sacrificed on specific days from both groups. Blood was collected along with the testis and pancreas. Tissues were immediately fixed in formalin, while blood was centrifuged and plasma was separated and stored at -20°C. Plasma levels of insulin, testosterone, and inhibin B were assessed through ELISA. Total oxidant status (TOS) and Total antioxidant capacity (TAC) of the plasma were measured by colorimetric assay. Tissue samples were processed for histology, and sections were stained with H&E. The first group depicts a

significant decrease in the insulin, testosterone, and TAC levels, while an increase in inhibin and TOS levels on the 15th day post-STZ. Interestingly, testicular histology shows normal and active seminiferous epithelium with elongating spermatids present in the tubule lumen on 5th, 10th and 15th day post-STZ. In the second zinc pretreated group, the hormonal analysis reveals that short-term hyperglycemia could not impact the testicular endocrinology in terms of testosterone and inhibin levels. The testicular histology also supported the endocrine profile by exhibiting active spermatogenesis and a seminiferous tubule lumen containing elongating sperms. The current study implicates that hyperglycemic conditions severely impact the testicular endocrinology of adult male Wistar rats, while zinc supplementation shields the negative impact of hyperglycemia on testicular steroidogenesis. Although the active spermatogenesis was observed in the first group on the 15th day, with reduced testosterone levels, we speculate that the impact of low testosterone will be unnoticeable in terms of spermatogenesis in the 15-day window.

Keywords: Diabetes mellitus, testosterone, hyperglycemia, streptozotocin, total oxidant status, zinc

ZOO-1848: Successful Cryopreservation of Sex Sorted Spermatozoa to Improve the Outcome of Breeding in Water Buffalo

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We investigated the cryopreservation protocol for sex sorted water buffalo spermatozoa. Sex-sorting of spermatozoa was carried out in three different techniques i.e. modified swim-up, paramagnetic nanoparticles and differential pH. After sorting, sperm cryopreservation was carried out. To optimize the sex sorted sperm cryopreservation technique, we tested three different cryodiluents. Briefly, the harvested sex-sorted spermatozoa were further divided into three parts and diluted in three different cryodiluents i.e. 1) tris-citric acid (TCA; Tris 3.0 g/100 mL, Citric acid 1.56 g/100 mL, Fructose 0.2 g/100 mL, Streptomycin sulfate 0.01 g/100 mL, fresh chicken egg yolk 20 mL, glycerol 7 mL, Distilled water 73 mL), 2) skimmed milk (SM; Skimmed milk 1 g/100 mL, Egg yolk 5 mL, Streptomycin sulfate 0.01 g/100 mL, Glycerol 7mL), and 3) commercial Triladyl® (TDL) to final concentration of 4×10^6 spermatozoa/ml respectively. Diluted samples were cooled to 4 ºC in 120 min and equilibrated at 4ºC for 4 hours, packaged in 0.54 mL French straws, frozen from initial holding at +4°C for 2 min, from +4°C to −20°C at 10 ºCmin−1, from −20°C to −100°C at 30°C min−1 and final holding for 1 min at −100°C with programmable freezer and stored in liquid nitrogen at -196ºC. Post- thaw analysis was performed 24 hours after freezing. Wherein, the total motility (TM), progressive motility (PM), rapid velocity (RV) plasma membrane integrity (PMI), viability along with acrosomal integrity (VIA/IACR) of spermatozoa were determined. At post-thawing, results of TM

(78.55±2.02), PM (31.83±1.85), RV (34.00±3.49), PMI (60.12±2.92) and VIA/IACR (58.84±1.93) were significantly higher in TDL as compared to other groups. In conclusion, Triladyl® is the extender of choice for the cryopreservation of buffalo sexed spermatozoa.

Keywords: Water Buffalo (Bubalus bubalis), Artificial breeding, Spermatozoa, Sex sorting, Cryopreservation, Cryo-injuries; Cryodiluent, Triladyl®; Tris-cirtric acid, Skim-milk, Post-thawquality

ZOO-1849: Prospects of Nanotechnology in Buffalo Breeding; Effect of Cerium Oxide Nanoparticles on Post-Thaw Quality of Water Buffalo Spermatozoa

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Nanoparticles of cerium oxide (nano-ceria) possess reactive oxygen species (ROS) scavenging properties as they mimic superoxide dismutase and catalase in biological systems. Therefore, present study aimed to investigate the effects of incorporating nano-ceria in the cryo- diluent on post-thaw sperm antioxidant profile and quality attributes in water buffalo. Semen samples from five mature bulls were collected and evaluated. Qualified samples were pooled, divided into 5 aliquots and diluted in Tris-citric acid extender containing differential concentrations of nanoparticles (0.14 µmol L-1, 0.29 µmol L-1, 0.43 µmol L-1, 0.58 µmol L-1 and negative control). Samples were cooled to 4 ºC for 120 min and equilibrated at 4 ºC for 4 hours, packaged in 0.54 mL French straws, frozen from initial holding at +4°C for 2 min, from +4°C to −20°C at 10 ºC min−1, from −20°C to −100°C at 30°C min−1 and final holding for 1 min at −100°C with programmable freezer and stored in liquid nitrogen at -196 ºC. At post-thaw, various *in vitro* sperm antioxidant enzyme profiles and other quality parameters were determined. At post-thawing, levels of catalase (0.28 ± 0.015 unit mg-1) peroxidase (0.24 ± 0.003 unit mg-1) and reduced glutathione (40.40 ± 2.12 µmol L-1) were highest (P< 0.05) with 0.43 µmol L-1 of nano-ceria as compared to negative control and other treatment groups. Moreover, lipid peroxidation (0.79 ± 0.02 nmol L-1 min-1 mg protein- 1) level was lowest (P< 0.05) with 0.43 µmol L-1 of nano-ceria. Results also revealed that 0.43 µmol L-1 exhibited higher (P < 0.05) sperm progressive motility (31.51 ± 1.51), rapid velocity (40.12 ± 1.90), average path velocity (78.00 ± 1.20), straight linear velocity (65.23 ± 1.28), curved linear velocity (101.2 ±3.2), supra-vital plasma membrane integrity (62.31 ± 1.28), viability (56.82 ± 2.01) and DNA integrity (97.00 ± 2.05) than control and other treatment groups. We concluded that the 0.43 µmol L-1 of nano-ceria in cryodiluent improved the post-thaw quality of water buffalo spermatozoa in terms of elevated levels of endogenous antioxidant enzymes, improved structural and functional integrity.

Keywords: Water buffalo (Bubalus bubalis); Artificial breeding; Spermatozoa; Cryopreservation; Oxidative stress; Antioxidant; Nanoparticles; Cerium Oxide; Post-thaw quality

ZOO-1850: Outcome of Controlled Breeding is Improved with Laparoscopic Artificial Insemination (LAI) Technique in Beetal Does

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Artificial insemination (AI) is the top of the list breeding technique to deposit superior genetic male germplasm in Beetal does. This is the first study in Pakistan in Beetal does, in which the efficacies of modern laparoscopic vs. conventional cervical AI techniques are investigated in estrus synchronized Beetal does during the peak breeding season. In experiment I, forty-eight non-pregnant Beetal does in 2nd lactation were estrus synchronized with 7-day progesterone- based protocol. Sponge containing 60 mg medroxyprogesterone acetate (MAP: ESPONJAVET® Hirpa Laboratories Spain) inserted intravaginally for 7 days, 75 µg of cloprostenol sodium (1mL Dalmazine FATRO® Italy) and 300 IU of Pregnant Mare Serum Gonadotrophin (PMSG: 3mL OVISER Hirpa Laboratories Spain) were administered intramuscularly on day 7. At 16 hours after standing estrus (standing estrus detected with aproned teaser buck), laparoscopic AI (LAI) was performed in twenty-one and cervical AI in nineteen does by using fresh semen of Beetal buck. In experiment II, forty-nine non- pregnant Beetal does in 2nd lactation were estrus synchronized with intravaginal sponge containing 60 mg MAP for 11 days. On day 9, 75 µg of cloprostenol sodium and 300 IU of PMSG was administered intramuscularly. At 56 hours after sponge removal, twenty does were inseminated through LAI and twenty-three through cervical AI with frozen thawed Beetal buck spermatozoa. Pregnancy was diagnosed at 50 days post AI through trans-abdominal ultrasonography. The data on pregnancy rate per AI and prolificacy were analyzed through Chi- square test of association and t test respectively by using Minitab software. The probability level having *P* value less than 0.05 was considered significant. No significant difference was recorded between 7-day and l1-day estrus synchronization protocols with respect to estrus response (83.33 vs 87.75%, respectively) and estrus interval (43.8 ± 1.99 vs 40.17 ± 1.43 hours, respectively). In both experiments, the pregnancy rates per AI was significantly higher in LAI group as compared to cervical AI by using fresh (71.42 vs 26.1 %, respectively) and frozen thawed Beetal buck spermatozoa (60 vs 42.1 %, respectively). The prolificacy did not differ significantly between LAI and Cervical AI groups of Experiment I (1.26 vs. 1.25, respectively) and experiment II (1.25 vs. 1.33, respectively). In conclusion, the findings of this study indicate that LAI technique improves the outcome of controlled breeding in Beetal does during the peak breeding season.

Keywords: Controlled Breeding Technology, Laparoscopic Artificial Insemination, Beetal does, Pregnancy rate per AI.

ZOO-1851: *In-Silico* Identification of Potential Phytochemical Inhibitors of Uridine-Cytidine Kinase 2 in Hepatocellular Carcinoma

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Hepatocellular carcinoma is the most common type of primary liver malignancies. About 80-90% of all primary liver malignancies globally are caused by it. HCC is the most prevalent kind of liver cancer, and a major cause of cancer related deaths worldwide. The over expression of Uridine-cytidine Kinase 2 protein is observed in the liver cells of the patients afflicted with hepatocellular carcinoma (HCC). One of the effective strategies to improve the outcomes of HCC treatment is to target the UCK-2 with therapeutic activity. Present study was designed to explore the inhibitor for the over expressing protein. *In-silico* approaches to investigate the potential phytochemical functioning as UCK-2 protein inhibitor was employed. Molecular docking was performed to find the potential phytochemical having lowest binding energy, to assess the inhibitory effects and binding relationships between UCK-2 protein and particular phytochemical. We have further considered ADMET features that are relevant in recruiting compounds as therapeutic agents. As a result, potential phytochemical (Piroxicam) with ligand ID (CID_54676228) having lowest binding energy about -8.6 kcal/mole was obtained. To check the validity of our result, we performed molecular docking of a naturally binding inhibitor named as UCK 2 Inhibitor-3 as a reference compound that showed binding energy of about -6.9 kcal/mole. This validation showed that our obtained phytochemical (Piroxicam) with comparatively low binding energy is more stable compound than naturally bind ligand and can be used to inhibit the overexpression of UCK2 as well as therapeutic agent for HCC.

Keywords: Hepatocellular carcinoma (HCC), UCK2 (Uridine-Cytidine Kinase 2), Molecular docking, Phytochemicals, Piroxicam

ZOO-1924: Prevalence and Risk Factors of Iron Deficiency during Pregnancy in the District Peshawar

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Iron deficiency anemia (IDA) is a widespread nutritional disorder during pregnancy, particularly in low- and middle-income countries, where it contributes to maternal and neonatal morbidity. This study assessed the prevalence, symptoms, dietary habits, and risk factors of IDA among pregnant women attending the Government Maternity Hospital, Peshawar, Pakistan. A total of 200 women were surveyed using structured questionnaires and hemoglobin testing. Results showed that 76% were anemic, with higher prevalence in women aged above 26 years and in the third trimester (54.9%), where moderate and severe anemia predominated. Rural (72.11%) and hilly (88.24%) residents, women of low socioeconomic status (64%), and those without formal education (75.5%) were disproportionately affected. More than half of the anemic women were not taking iron supplements (51.97%). Dietary assessment revealed excessive tea consumption (80.27%) and low intake of milk (35.53%), fruits (34.86%), and vegetables (8.26%), reducing iron absorption. Common symptoms included dizziness (69.5%), headache (60.5%), and taste disturbance (60%), while major risk factors were multiparity (64.5%), poor nutrition (55.5%), vomiting (54.5%), poor compliance with supplementation (51%), heavy menses (24.5%), and abortion (20%). These findings highlight that IDA is highly prevalent among pregnant women in Peshawar, strongly linked to socioeconomic, dietary, and reproductive determinants. Effective interventions through nutritional education, iron supplementation programs, and improved maternal healthcare services are urgently needed to reduce the burden of IDA and ensure better maternal and fetal outcomes.

Keywords: Iron deficiency anemia, maternal health, pregnancy outcomes, nutritional risk factors, hemoglobin, supplementation.

ZOO-1940: *In-Silico* Analysis of Potential Phytochemical Targeting Glutathione Peroxidase 4(GPX4) in Thyroid Cancer

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Thyroid cancer, regarded as a highly prevalent cancerin woman around the world. The incidence of thyroid tumorigenesis increasing day by day. Thyroid tumors formed because of over- expression of GPX4 protein, play role in ferroptosis by regulating oxidative stress. Hence targeting GPX4 can be a potential therapeutic agent in thyroid carcinoma. *In-Silico* studies have been carried out to find out the efficacy of various phytochemicals in the treatment of thyroid cancer and down

regulating GPX4. Thus, over expressed protein docked against 96 ligands by molecular docking. Ligands (phytochemicals) were selected and screened on ADMET criteria which are useful for identifying compounds as therapeutic agents. Result findings suggest Piroxicam as top ligand with binding energy of -7.5kcal/mol. For further validation analysis, RSL3, a natural inhibitor of GPX4 used and docked against protein that gave -7.2kcal/mol binding energy, that makes piroxicam as more suitable. This validation showed that obtained phytochemical (piroxicam) is more stable compound than naturally bind ligand (RSL3) and can be used to inhibit the overexpression of GPX4 as well as therapeutic agent for thyroid cancer.

Keywords: Thyroid Cancer, GPX4, Molecular Docking, Phytochemicals

ZOO-1941: Computational Identification of Phytochemical Inhibitor Targeting Ubiquitin Carboxyl Terminal Hydrolase L3 (UCHL3) in Cervical Cancer

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One of the primary causes of death for women is still cervical cancer globally. Despite advancements in conventional therapies, limitations such as drug resistance, toxicity, and recurrence highlight the urgent need for safer and more effective alternatives. The overexpression of Ubiquitin C-terminal hydrolase L3 (UCHL3) protein significantly linked to many cases in cervical cancer, so it is a viable tactic to enhance cervical cancer treatment. This study was designed to explore phytochemical as natural inhibitor of UCHL3 in cervical cancer. In this study, in-silico techniques were used to identify role of phytochemicals as inhibitors of UCHL3. Through molecular docking, binding potential of 95 naturally occurring phytochemicals were evaluated against UCHL3. Ligands (phytochemicals) were selected and screened on ADMET criteria which are useful for identifying compounds as therapeutic agents. Among docked compounds, top one compound Wistin emerged as strong binder because of its lowest binding energy (-7.7) and more stability within active site of UCHL3. Farrerol, natural ligand of UCHL3 was used as reference compound and its docking result with UCHL3 gave the binding energy of -7.0, indicating stability and efficacy of wistin. This validation showed that obtained phytochemical (wistin) is more stable compound than naturally bind ligand (farrerol) and can be used to inhibit the overexpression of UCHL3 and supports the exploration of phytochemicals as novel, less toxic alternatives for cervical cancer management.

Keywords: Cervical Cancer, Ubiquitin Carboxyl Terminal Hydrolase L3 (UCHL3), Molecular Docking, Phytochemicals, Wistin

ZOO-1978: Mutational Analysis of *FKRP* Gene Associated with Neurodevelopmental Disorder in Consanguineous Pakistani Families

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Neurodevelopmental disorders are genetically heterogenous group of disorders which are characterized by mental conditions affecting the development of nervous system. NDDs are highly heterogenous due to their clinical characteristics, etiology, outcomes and treatments responses. NNDs are mostly genetic and occur due to genetic mutations. Moreover, prevalence of neurodevelopmental disorders varies depending upon population and consanguinity practices. This study investigated two families with distinct neurodevelopmental disorders phenotypes. Both families were recruited from south Punjab region of Pakistan showing the clinical features of neurodevelopmental disorder mainly intellectual disability and informed written consent was taken from the guardian of each family. After acquiring the clinical data, blood samples were taken from each family for DNA isolation. DNA was extracted from blood by using the phenol-chloroform method. One Family, affected with NNDs underwent targeted Sanger sequencing, which resulted in the identification of homozygous insertion (Chr19:47259561- 47259562insA) in the coding region of exon 4 of *FKRP* gene. Mutation taster and other *in-silico* tools predicted it as pathogenic variant. In the same way, another family, afflicted with neurodevelopmental disorders, also underwent Sanger sequencing, but we could not find any variant in *FKRP* gene. Further advanced screening techniques such as whole genome sequencing (WGS) can be performed in the studied family B to provide genetic diagnosis and mutational analysis.

Keywords: Neurodevelopmental disorders, Intellectual disability, Sanger sequencing, FKRP, Whole genome sequencing

ZOO-1986: Mutation Analysis of Exon 11 of *CFTR* Gene among Cystic Fibrosis Patients from Southern Punjab, Pakistan

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Cystic Fibrosis, an autosomal recessive disorder of genetic origin, is primarily caused by mutations in the cystic fibrosis transmembrane conductance regulator gene. The mutated gene produces CFTR protein that is unable to maintain ion balance across cell membranes. More than 2,000 mutations have been identified in the CFTR gene. The cystic fibrosis transmembrane conductance regulator gene (CFTR gene), located at chromosome number 7, encodes for CFTR protein. The

malfunctioning of CFTR protein causes irregularities in cellular electrolytes and water balance that leads to thickness of secretions and ultimately clog the airways and glandular ducts. Severity of this condition leads to death of individuals by affecting multiple organs especially lungs and pancreas. The mutated gene produces CFTR protein that is unable to maintain ion balance across cell membranes. More than 2,000 mutations have been identified in the CFTR gene. However, Pakistan's mutational spectrum is still unknown. The prevalence of Cystic Fibrosis (CF) in Pakistan is not known to certainty. CF is under diagnosed and under reported disease in Pakistan due to many reasons. Cystic Fibrosis disease causative mutations are rarely studied in Pakistan, especially no studies available on local populations of Southern Punjab Pakistan. Therefore, current study was persuaded to sequence the exon 11 of CFTR gene in CF patients of Southern Punjab region, Pakistan. The exon 11 of CFTR gene hosts ΔF508 mutation which is most prevalent mutation of CFTR gene and exist in more than 66% CF patients of whole world and even up to 100% CF patients of some of isolated/conserved populations as of Fore Islands (Denmark). To fulfill the objectives of this study, Sanger sequencing technique was applied to sequence the exon 11 to detect ΔF508 CFTR gene mutation or if any other mutation on exon 11 in local population of Southern Punjab, Pakistan. Genomic DNA of 12 CF patients was extracted from blood samples. Two primers, each of 21 bp designed through Primer-3 software and used to PCR amplify the exon 11 of CFTR gene of all DNA samples in 306bp PCR amplicons through thermal cycler (PCR machine). PCR products (306bp) of exon 11 was sequenced through Sanger sequencing/capillary electrophoresis. The sequenced results were analyzed for mutational investigation which predicted that ΔF508 mutation or any other causative mutation in all 12 Cystic Fibrosis patients. That one is homozygous ΔF508 out of 12 patients. These results suggest that ΔF508 mutation of exon 11 is uncommon in population under study unlike other global populations due to genetic diversity in different ethnic populations. Availability of samples for recent research work was a challenging task as CF is a rare disease, so, a large-scale genomic study is recommended to find the mutational spectrum of whole *CFTR* gene and develop an effective mutational profile for better disease management and its treatment in Pakistan.

Keywords: Cystic Fibrosis, CFTR Gene, ΔF508 mutation, sanger sequencing, Southern Punjab, Pakistan

ZOO-2065: Studying the Expressional Alterations of miR-296-3p And DDHD2 Gene in Patients with Thyroid Cancer

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Thyroid cancer, the most common endocrine malignancy, is increasing in incidence globally, underscoring the need for novel diagnostic and prognostic biomarkers. This study aimed to evaluate the expressional patterns of miR-296-3p

and the DDHD2 gene and their potential role in thyroid carcinogenesis. This study was conducted on histopathologically confirmed thyroid cancer patients and both cancerous tissue and their adjacent normal tissues were collected after surgery. Demographic and clinical data including age, gender, thyroid function status (TSH, T3, and T4 levels), tumor size, cancer stage, and family history were recorded. While gene and miRNA expression levels were assessed using quantitative real-time PCR (qRT-PCR). Demographic analysis showed a mean patient age of 40 years, with majority of patients were female which is consistent with known epidemiological trends and tumors were predominantly detected at early stages with moderate sizes. Hormonal analysis showed that the majority of patients had mean TSH (2.9 mIU/L), T4 (9.92 µg/dL), and T3 (2.57 pg/mL) levels within normal ranges. Family history revealed that most cases were sporadic, with limited familial links. Molecular analysis showed significant upregulation of miR-296-3p in tumor tissues in thyroid cancer. Although miR-296-3p is reported as a tumor suppressor in several previously reported studies like on NSCLC and colorectal cancer, in this study (and in glioblastoma), its overexpression suggests a possible oncogenic role in thyroid cancer. Similarly, the DDHD2 gene was also significantly upregulated in thyroid cancer, aligning with prior findings of its involvement in lipid signaling and tumor progression in papillary thyroid cancer and breast cancer. A moderate positive correlation between miR-296-3p and DDHD2 was observed in thyroid cancer, suggesting a possible co-regulation mechanism. These results highlight the potential of miR-296-3p and DDHD2 as diagnostic biomarkers and therapeutic targets in thyroid cancer. This study provides critical insight into the molecular landscape of thyroid cancer within the Pakistani population and supports further validation through large-scale studies.

Keywords: Thyroid cancer, Biomarkers, miRNA-296-3p, DDHD2 gene, MicroRNAs (miRNAs)

ZOO-2067: Differential Expression Analysis of miR-1205 and E2F3 in Breast Cancer Tissues

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Breast cancer continues to remain one of the most common cancers that affect women globally, and it develops and spreads due to intricate molecular processes. E2F3 and miR-1205 expression analysis was carried out to investigate their respective functions and possible interactions in breast cancer. Following the extraction of total RNA from the tissue samples, cDNA was synthesized using a commercial cDNA kit. While Real-time PCR (qPCR) was used to quantitatively assess gene expression. The difference in gene expression between cancerous and normal tissues was examined, unpaired student's t-test was employed by using SPSS 20.00. To ascertain the link between the E2F3 gene, miRNA expressional dysregulations, and the risk of breast cancer in the population being studied,

Pearson correlation was applied. Data was displayed as mean ± standard error of the mean in graph plots created with SPSS software, and p-values below 0.05 considered to be statistically significant. Additionally, the expression profiles of E2F3 and miR-1205 were also examined in connection with demographic and clinic pathological characteristics (e.g., age, marital status, lactation history, nipple discharge, tumor size, tumor grade, stage, hormone receptor status, breast cancer type, breast surgery, and metastasis). This made it easier to ascertain if these molecular markers are connected to certain clinical outcomes or disease characteristics. The study found that cancerous samples showed higher average fold change expression of the E2F3 gene compared to normal tissues. It was also noted that, although this difference is not statistically significant, miR-1205 expression is often lower in malignant breast tissues than in normal tissues. The results of this study provide a foundation for the possible application of miR-1205 and E2F3, which has shown potential as a detective, predictive, and therapeutic marker in breast cancer. However, further studies with larger and more diverse patient groups are needed to confirm its clinical utility.

Keywords: Breast Cancer, miR-1205, E2F3 Gene, Biomarkers, Tumor Suppressor

ZOO-2068: Molecular Profiling of Mir-1205 and E2f3 in Papillary Thyroid Carcinoma: A Pakistan Cohort Study

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Papillary thyroid carcinoma (PTC) is the most common endocrine malignancy, accounting for nearly 96% of thyroid cancers worldwide, and showing the prevalence of 73.7% in Pakistan, predominantly affecting middle-aged women. Despite improvements in diagnostic methods, the molecular mechanisms contributing to PTC progression remain incompletely defined. This study aimed to evaluate the expression of microRNA-1205 and the transcription factor E2F3, and to explore their association with clinical features of PTC. Fifty patients with histologically confirmed PTC were recruited from hospitals in Rawalpindi and Islamabad after obtaining ethical approval. Paired tumor and adjacent normal thyroid tissues were collected alongside demographic and clinical data, including age, gender, tumor size, stage and thyroid hormone levels. TSH, T3 and T4. RNA was extracted, reverse-transcribed into cDNA and analyzed using real-time PCR. Expression levels of miR-1205 and E2F3 were quantified with GAPDH as reference. Statistical correlations with clinical parameters were assessed using SPSS software. Both miR-1205 and E2F3 were upregulated in PTC tissues compared to adjacent controls. Mean fold changes were 1.0 vs 0 .7 for miR-1205 and 45 vs 10 for E2F3. However, differences were not statistically significant. ($P > 0.05$). Correlation analysis revealed weak known significant associations between miR-1205 and age, tumor size, and thyroid hormone levels. Similar non-significant correlations were observed for E2F3. A weak positive trend was noted

between miR-1205 and E2F3 expression. The study highlighted measurable upregulation of miR-1205 and E2F3 in PTC, suggesting potential oncogenic roles. Although statistical significance was lacking, the findings support further investigation of these markers in larger cohorts and functional studies to clarify their roles in thyroid tumorigenesis and their value as potential biomarkers.

Keywords: Papillary thyroid carcinoma, miR-1205, E2F3, Gene expression, Biomarker.

ZOO-2069: Thyroid Function and its Clinical Implication on Liver Cirrhosis: A Study in District Gujrat, Punjab, Pakistan

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The cirrhosis is one of last phases of chronic liver disease. During the development of liver cirrhosis from compensated phase to the decompensated phase, a lot of complications happen that cause remarkable decrease in the life prognosis. The underline diseases like hepatitis B and C, alcohol consumption and non-alcoholic fatty liver disease cause cirrhosis and cirrhosis can easily lead to hepatocellular carcinoma that is type of primary liver cancer and also to liver failure. Thyroid hormones profiling has been linked to worse outcomes for people with cirrhosis. It can be used as effective technique in clinical practices. The main objective of this study was toward the study of the clinical implication of thyroid function in liver cirrhosis in District Gujrat, Punjab, Pakistan. Thyroid hormones (TSH, T3 AND T4) was measured in blood samples taken from participants of experimental and control group over a four-month period as part of a cross-sectional study. Examining the thyroid hormone levels, the severity, and the diagnostic techniques of liver cirrhosis were the main goals. The results showed that there was positive relation between TSH level and child Pugh score. There is also positive relation between TSH level and severity of liver cirrhosis. The results contribute in understanding association of liver disorders and endocrine dysfunction, early diagnosis and management of liver cirrhosis.

Keywords: liver cirrhosis, TSH level, endocrine dysfunction, early diagnosis.

ZOO-2070: Evaluation of Hcv Genotype Circulating in Population of District Gujrat Punjab Pakistan

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One of the primary causes of persistent liver illness in the entire world is the hepatitis C virus. Although some hepatitis C instances may resolve on their own, but most of people will develop a chronic infection. Hepatitis C disease might potentially present with extra hepatic symptoms. Millions of individuals worldwide have been afflicted with the viral illness hepatitis C (HCV).The prevalence of transmission of HCV fluctuates by region and is substantial worldwide. The primary cause of many cancers, including cancer of the liver, is HCV infection. The genetic variants and subcategories of HCV as well as diagnostic and social characteristics that characterize those with risk factors linked to a high incidence of contracting HCV was examined in this research investigation. From November 2024 to August 2025, samples of blood from 341 individuals who were suspected were obtained. ELISA and quantitative PCR were used to test for HCV infection, and Real Time PCR molecular genotyping was used to confirmed cases. The maximum viral load was seen in age group 15 to 30 and the percentage of females was greater (58.2%) than that of males (41.8%). 3a (81.76%) and 2b (17.25%) was more prevalent genotype as compared to 1a, 3b and mixed genotypes. The greatest rate of HCV prevalence. Compared to males, females were more infected, and the most prevalent genotype was 3a.Then ELISA test was performed for further and accurate confirmation. The technique called real time PCR was done to detect the quantity of virus (viral load) per milliliters of serum sample. This study contributed to the overall distribution of the HCV genotypes and their correlation with various age and sex groups. The current research sought to determine the prevalence of HCV infection in addition to Classification and sub categories in the Punjab region, District Gujrat.

Keywords: Immunochromatographic test, ELISA, qPCR, HCV genotype

ZOO-2071: Cleft Lip and Palate in Pakistan: Epidemiology, Clinical Spectrum, and Research trends

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Pakistan has one of the world's highest incidences of cleft lip and palate (CL/P worldwide. Despite this burden, there remains scarcity of comprehensive data on its socio-demographic determinants, clinical variability, and research landscape in the multiethnic population of Pakistan. This work aimed to: (1) identify socio-demographic, maternal, and obstetric risk factors for CL/P; (2) describe the clinical and ethno-demographic variability of CL/P subtypes; and m(3) review national research trends and gaps. This project integrated findings from a multicenter

case-control study (2021–2024) and a systematic review. The case-control study included 730 participants (303 cases, 427 controls) recruited from tertiary hospitals and rural areas of Islamabad/Rawalpindi and Potohar region. Data on demographic, maternal, and clinical variables were analyzed using descriptive, bivariate, and multivariable logistic regression methods. The systematic review (1997–2023) synthesized 93 studies from literature available online. The case-control analysis revealed key risk factors: parental consanguinity (64% of cases), maternal depression during pregnancy, inadequate folic acid/vitamin use, first parity, and socio-demographic influences such as province, caste, family type, and father's occupation. Cleft lip and palate (53%) was the most common phenotype, followed by cleft palate (28%) and cleft lip only (19%), with 67% being complete clefts. A male predominance (55%) and high rural representation (69%) were observed. The review highlighted a research bias toward surgical and dental management, with limited work on incidence, etiology, and molecular genetics. This integrated study underscores the multifactorial etiology of CL/P in Pakistan and emphasizes the need for large-scale, multiethnic research and targeted public health interventions addressing modifiable maternal and environmental risk factors.

Keywords: Cleft lip, cleft palate, congenital anomalies, epidemiology, genetic heterogeneity

ZOO-2072: Trends of Gastrointestinal parasites in Domestic pigeons in Gujrat

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Pigeons have long history of association with humans across the world. They are raised and bred for a variety of purposes, including meat, entertainment, money, and religion. Present study was aimed to establish the incidence of intestinal parasites and their effect on blood profile of domestic pigeons (Columba livia domestica). 80 fecal and blood samples (40 males and 40 females) were taken and examined according to defined parasitological and hematological methods. The parasite species detected were Ascaridia columbae (58.8%), Capillaria sp.(62.3%), Heterakis gallinarum (13.8%), Strongyloides sp.(10%)., Gongylonema sp.(2.5%), and Spirurid sp. (13.8%) along with Eimeria columbae (57.5%) a protozoan, while Raillietina tetragona (45%) a Cestode. The findings showed a high incidence of intestinal parasitic infections, with overall frequency of 87.5% Capillaria sp. (62.3%), being the most common found parasite, followed by Ascaridia columbae(58.8%), Eimeria columbae (57.5%), and other helminthes at less frequencies. Statistical analysis revealed that female pigeons had a considerably greater frequency of parasitic illnesses, whereas there were no significant differences across pigeon breeds. Hematological study revealed that parasite infections had a small overall effect on blood parameters. The white blood cell (WBC) count increased in infected birds, indicating an immunological response and HB level decreases. Other metrics, such as red blood cell count

(RBC), and packed cell volume (PCV), remained within normal limits and did not differ significantly between infected and unaffected birds. These findings suggest there is need of further study investigate hormonal and environmental variables that influence susceptibility.
Keywords: Gastrointestinal Parasites, Pigeons, Packed cell volume, Ascaridia columbae

ABSTRACTS
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BOTANY

BOT-1579: Ethnobotany and Phytogeography of Medicinal Plants for Management of diseases of District Sudhnuti AJK, Pakistan

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Azad Jammu and Kashmir is the hotspot area and center for many important medicinal plants species. Sudhnuti district boasts a rich diversity of plant species many of which have medicinal properties. The district flora includes a wide variety of herbs, shrubs, trees and climbers each adapted to specific ecological niche. There is wide range of economically significant plants particularly in mountain region that is actuality cast-off by native people to combat diverse diseases. Surveys then interviews will be conducted and information isrecorded on questionnaire along with recipes for the treatment of different diseases.The ethnobotanical knowledge and medicinal plant variety of District Sudhnuti in AJK, Pakistan—a region renowned for its biodiversity and rich cultural traditions—are examined in this study. Due to limited access to modern healthcare, local communities primarily depend on on herbal medicines as a form of treatment. Inthe Garala region, both male and female informants took part in field surveys and semi-structured interviews. In adding to documenting 75 plant species from 40 botanical families, wide ethnomedicinal data about the applications of plants, their preparation, and the diseases they cure were learned. The findings indicate that older women, in particular, hold crucial knowledge about herbal therapy, including the creation of pastes, infusions, and decoctions. The most widely employed plant components were leaves, which had numerous uses for conditions relating to the skin, lungs, digestive system, and mind. Along with information on each species' botanical characteristics, habitat, flowering season, and traditional medical uses, there is also a carefully curated list of 70 significant medicinal plants. This study supports the application of ethnobotany in biodiversity management, cultural preservation, and sustainable healthcare, emphasizing the need of conservation indigenous knowledge systems. The study also demands for added pharmacological research to validate and possibly assimilate these traditional treatments into current healing.

Keywords: Ethno botanical study, District Sudhnuti, medicinal plants, phytogeography, Herbal formulation, Traditional knowledge.

BOT-1642: Effect of *Cassia angustifolia* Vahl. based copper nanoparticles on the growth attributes of maize (*Zea mays* L.)

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Nanotechnology holds immense potential in agriculture, offering innovative solutions to enhance crop productivity, stress tolerance and sustainable resource management. This study explores the potential of green-synthesized copper nanoparticles (CuNPs) from *Cassia angustifolia* Vahl. leaf extract to improve maize growth. For this, two optimal concentrations (5 and 15 ppm) were selected from preliminary screening to test the early growth parameters (e.g., germination percentage, root and shoot length, fresh and dry weight of seedlings) of five different maize varieties (Neelum, Islamabad white, NARC 3, Haq Nawaz Gold and S-2002) in petri plates. As a result, two high-performing varieties (Neelum and NARC 3) were identified and cultivated in pots under three conditions for 21 days: normal (irrigation with water), drought (irrigation withheld), and saline (irrigation with 150 mM NaCl solution) to assess the long-term effect of Cu nanoparticles on maize. Our findings reveal a clear dose-dependent effect, where low concentrations of CuNPs consistently yielded optimal improvements in key growth parameters in both in vitro and in vivo studies. Crucially, CuNP application effectively mitigated the detrimental impacts of both saline and drought stress, promoting healthier plant development. These findings position green synthesized CuNPs as a promising tool for boosting maize growth and productivity.

Keywords: Copper Nanoparticles, Green Synthesis, Maize, Drought Stress, Salinity Stress, Dose-Dependent.

BOT-1646: Isolation and Characterization of Metal Resistant Endophytic Bacteria from *Cynodon dactylon* (L.) Pers.

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The heavy metal contamination of soil poses a significant threat to the ecosystem and human health. *Cynodon dactylon* (L.) Pers., commonly known as Bermuda grass, is known for its ability to survive in a contaminated site. This study aims to isolate and characterize metal-resistant bacterial endophytes from *C. dactylon*. Endophytic bacteria help plants to ensure their survival under stressed conditions. By using sterilization and microbial culturing methods, twenty-four different bacterial isolates were recovered from healthy plant tissues of *C. dactylon*. Colony morphology and Gram staining were studied with the help of Binocular microscope. In order to study various metabolic capabilities of bacterial isolates, different biochemical tests like catalase test, methyl red assay and protease production test were performed. These morphological and biochemical characterization techniques were used to identify potential candidates that are

helpful in phytoremediation. Different PGP activities, including IAA and Ammonia production, along with Phosphate solubilization, were studied, focusing on their potential role in plant growth promotion and sustainability. These isolates were also screened in order to check how they resist heavy metals such as Pb, Zn, Cr and Cu. The bacterium CDL2 and CDR1 showed maximum resistance to heavy metals at all concentrations. Seed germination assay exhibits the beneficial role of selected bacterial isolates on plant growth and germination. The bacterium CDR6-inoculated seeds of *Linum usitatissimum* L. showed an increase in germination percentage of 91.1% to the control of 66.6%. This synergistic effect of PGP traits, stress tolerance and remediation potential reflect the significance of bacterial isolates in improving plant growth in a metal-contaminated environment. This research is helpful in exploring microbial diversity of *C. dactylon* and remediating heavy metal- contaminated soils, exploiting plant-microbe interactions.

Keywords: Bacterial endophytes, Cynodon dactylon, heavy metal resistance, plant growth-promoting traits, Seed Germination.

BOT-1656: Molecular Characterization and Phylogenetic Assessment of Selected Asteraceae Species from Margalla Hills

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Asteraceae is a largest angiosperm family of vascularplants in Pakistan having medicinal, nutritional and ornamental values. Some of the species are being used as vegetable such as Chicory and Lettuce and others are important for oil production such as Sunflower. Margalla Hills are considered as a home for many Asteraceae species. So current study focused on estimation of genetic diversity and phylogenetic analysis in selected Asteraceae species present in Margalla Hills. The objective of our study was to explore Asteraceae species of Margalla Hills using molecular techniques and shedding light on evolutionary relationships among them as well as designing conservation strategies for them. For molecular analysis, IPBS primers (2374 and 2378) were used. After extraction of DNA through Cetyl Trimethyl Ammonium Bromide (CTAB) method, amplification was done at annealing temperature (53.0-53.7). Genetic diversity among 11 species was assessed using iPBS primers(2374 and 2378). Primer 2378 generated total 60 bands and 2374 produced 36 bands which indicate high polymorphism rate for primer 2378. Polymorphic Information Content (PIC) values were ranging from (0.165 to 0.463) for primer 2374 and (0.298 to 0.496) for primer 2378, indicating their efficiency in detecting genetic variation. Genetic diversity indices revealed species-specific differences, where *Chrysanthemum morifolium showed great diversity indices values for primer 2374 such as* (h=0.490, I=0.985 and Ne=0.960) and *Tagetes erecta* displayed the highest diversity i.e. (h=0.490) and (I=0.683) for primer 2378. Meanwhile, *Sonchus arvensis* exhibited minimal within-species variation despite a high PIC value. Jaccard's similarity index

highlighted variable interspecific affinities, with *Erigeron sumatrensis*, *Gamochaeta pensylvanica*, and *Taraxacum officinale* showing close similarity under primer 2374, while primer 2378 detected broader divergence. Phylogenetic dendrograms constructed using the Neighbor Joining method grouped the species into two distinct clades, reflecting their evolutionary divergence, which was further supported by Principal Coordinate Analysis (PCoA). Analysis of Molecular Variance (AMOVA) revealed that most of the genetic variation was distributed among species, emphasizing pronounced interspecific differentiation within the family. Overall, iPBS markers proved to be highly effective for assessing genetic diversity, evolutionary divergence, and phylogenetic relationships among Asteraceae species.

Keywords: Asteraceae, Margalla Hills, Molecular markers, Phylogenetic, Conservation, Evolutionary relationships.

BOT-1731: Role of Activated Rice Straw Biochar on Adsorption of Azithromycin From Aqueous Solution and its Reuse Ability

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A large number of antibiotics are continuously released into the environment because they are not completely metabolized by our body and azithromycin is one of them. The present study focused on assessment of activated biochar produced from rice straw for azithromycin adsorption from aqueous solution. Biochar was produced by pyrolysis at 500°C for two hours, activated with $ZnSO_4$ and analyzed by FTIR (Fourier-transform infrared spectroscopy), SEM (Scanning electron microscopy) and XRD (X-ray diffraction). Analysis revealed an amorphous structure having numerous functional groups (C–O, C=C), having rough and distorted morphology. The adsorption was mainly governed by the pH and contact time. The highest removal percentage of azithromycin was observed at pH 4 (94.5%) and contact time of 4hr (91%). Kinetic modeling revealed that the adsorption process in this study obeyed pseudo-second-order (R^2=0.99) model, suggesting that nature of the adsorption is chemisorption. Application of treated biochar (after regeneration) and filtered water (post adsorption) on the growth of *Brassica juncea* L. plant was further accessed. Role of treated biochar and filtered water on plant growth was comparatively accessed with pure biochar (untreated biochar) and control with normal soil and distilled water. Results showed that untreated biochar promote better growth when compared with treated biochar, and normal soil as a control promote better growth than filtered water. This study emphasized the role of activated biochar in azithromycin adsorption from waste water and its potency to be reused in plant growth as soil amendment.

Keywords: Azithromycin, Activated Rice Straw Biochar, Fourier transform infrared spectroscopy, X-ray diffraction, Kinetic model, Brassica juncea L.

BOT-1735: Molecular Markers Based Genetic Characterization of Selected Asteraceae Species

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The current study focused on the genetic characterization of chosen species of Asteraceae family by using molecular markers. Inter- Primer Binding Site (iPBS) markers are the most recent and advanced markers that has been used to examine genetic diversity of different plant species. So in this study two iPBS primers (2374 and 2224) were used to evaluate the genetic diversity and phylogeny of selected Asteraceae species. Ten species of Asteraceae was collected from different areas of Pakistan. Among them, 6 species were wild, while 4 species were cultivated. Genomic DNA was extracted from the leaf tissue by using CTAB method and PCR amplification was carried out using these two primers. Total 73 polymorphic bands were generated through amplification by both primers. Primer 2374 was appeared to be more efficient in detecting genetic variability as compared to primer 2224. In addition, 42 polymorphic bands were amplified by the primer 2374 with an average of 4.2 per locus while 2224 amplified 31 bands with an average of 3.1 per locus. The number of polymorphic bands produced by both primers reflect the strong capability to detect interspecific genomic variations. These phylogenetic trees were constructed by using PAST (4.03) software. These phylogenetic trees revealed the genetic variations between the selected species and demonstrated clear patterns of grouping indicating both genetic similarity and divergence within the Asteraceae species. The clustering highlights the potential evolutionary and taxonomic connections among the selected species. The results of this research reflect that iPBS marker are reliable molecular tool for estimating the genetic diversity and phylogenetic inference in Asteraceae species. Moreover, the performance of the primers emphasize that primer selection plays an important role in determination of genetic variations. The application of iPBS markers could contribute valuable data to plant molecular genetics and support future research on biodiversity conservation, breeding and evolutionary studies.

Keywords: Asteraceae, plant molecular genetic,s Inter-Primer Binding Site (iPBS) markers, Polymorphic bands, molecular tool

BOT-1769: Remediation of Ciprofloxacin from Soil using Activated Rice Straw Biochar and *Brassica Juncea* L. (Czern)

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The extensive use of Ciprofloxacin (CIP) in human healthcare and veterinary settings has resulted in accumulation in the soil environment through various pathways such as wastewater irrigation, application of biosolid, and the use of animal manure which has resulted in increased environmental contamination and potential risks to soil health and food safety. This study investigated the integrated phytoremediation approach to remove ciprofloxacin from soil using Brassica

juncea and activated rice straw biochar. Biochar was produced from rice straw by pyrolysis at 500□ C for two hours and chemically activated by potassium hydroxide (KOH), which offers high surface area for adsorption. FTIR and SEM revealed the presence of numerous functional group and high porosity of activated biochar. A controlled pot experiment was performed to assess the efficiency of individual and combined abilities of biochar and *B. juncea* on the degradation and immobilization of ciprofloxacin in artificially contaminated soil. Improvement in plant growth parameters and reduced oxidative stress were observed in activated biochar amendment soil. Ciprofloxacin concentration in soil and plants was analyzed by UV-Vis spectrophotometer. The results showed that KOH activated biochar enhanced the adsorption of CIP, while *B. juncea* demonstrated phytoextraction potential. The combined treatment of activated biochar with plants exhibited the highest removal efficiency (57%), indicating synergistic interaction between sorption and plant uptake. The calculated value of BCF□ 1 indicates the limited uptake CIP from soil due to high adsorption capacity of activated biochar. Translocation factor values demonstrated the plant ability to translocate CIP from roots to shoots. The findings highlighted the potential of using activated biochar assisted phytoremediation as a sustainable, low-cost and environmentally friendly approach for remediating antibiotic contaminated soil.

Keywords: Ciprofloxacin, environmental contamination, biochar, markers, remediating antibiotic contaminated soils

BOT-1775: Biological Evaluation of Fractionated Extracts of *Murraya Paniculata*

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Plants have been used for medicinal purpose since ancient time, providing bioactive constituents for therapeutic against infectious diseases. Phytomedicines are safe and non-toxic, playing a vital role in modern medicine. *Murraya paniculata* (family Rutaceae), is renowned for its traditional use of leaves as herbal remedies for various ailments. The current study was aimed to evaluate the pharmacological properties of polar and non-polar fractions of leaves of *Murraya paniculata*. Crude extract was prepared by cold maceration technique and was subjected to prepare hexane and aqueous fraction. *Murraya paniculata* hexane and aqueous fraction shown potent activity against brine shrimp nauplli. Gradual increase in mortality with an increase in concentration of the test sample was observed. Antioxidant potential of hexane and aqueous fraction of *Murraya paniculata* was examined through DPPH and Phosphomolybdate assay. All assay show significant antioxidant activity. The results are comparable to the standard ascorbic acid indicating that this plant has significant antioxidant activity. Phytotoxic activity of hexane and aqueous fraction of *Murraya paniculata* was examined by seed germination assay. The hexane and aqueous fractions of *Murraya paniculata* showed strong phytotoxic effects at higher concentrations (240 and 480ppm), with root length inhibition of 62.82% and 65.63%,

respectively. The hexane fraction caused earlier and more consistent suppression, while the aqueous fraction allowed limited delayed germination. Additionally the qualitative and quantitative phytochemical estimation of hexane fraction revealed the presence of tannins, alkaloids compounds, phenols, flavonoids. The phytochemical estimation of hexane fraction was examined on the basis of activities performed. Our results demonstrated that the polar and non-polar leaves fraction used in this study possess strong cytotoxic, antioxidant and phytotoxic activities.

Keywords: Phytomedicines, phytochemical constituents, cytotoxic, antioxidant, phytotoxic activity.

BOT-1782: Ethnobotanical Investigation and Ecosystem Services of Native Trees of Islamabad, Pakistan

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Urbanization and environmental degradation influence the ethnobotanical uses and ecosystem services of native trees. Islamabad, the capital territory of Pakistan, is known for its abundance of native trees and diverse flora. The study explores the ethnobotanical significance and ecosystem services of native trees in Islamabad, Pakistan. The most frequently used species include *Dalbergia sissoo* DC. (Shisham), *Ficus religiosa* L. (Peepal), and *Bauhinia variegata* L. (Kachnar). The dominant families include Fabaceae, Moraceae, Myrtaceae, and Meliaceae. The most cured diseases include diabetes, constipation, skin problems, hair problems, anemia, blood pressure, diarrhea, body weakness, stomach problems, and rheumatism. Native trees provide ecosystem services such as air pollution reduction, soil conservation, climate regulation, and wildlife habitat. It explores health benefits of native plants used for medical purposes, focusing on *Terminalia arjuna* Roxb. ex DC. (Arjun), *Ficus benghalensis* L. (Banyan), and *Azadirachta indica* A. Juss. (Neem). These native trees are used in the form of fruit and vegetables and to treat various diseases, such as skin problems, stomach problems, and fever. Several species hold cultural, societal, and religious significance as well, such as *Azadirachta indica* A. Juss., *Ficus religiosa* L., and *Ficus beng*halensis. The different modes of administration, as described by local inhabitants, including powders, pastes, decoctions, and infusions, are employed in combined forms for treating different diseases. The study emphasizes the importance of sustainable management and conservation of native tree species in Islamabad, highlighting their cultural, sociological, and economic significance. It also raises concerns about over-harvesting, grazing, and habitat degradation. It is important to adopt sustainable harvesting techniques and community participation for the conservation of native trees, as they serve multiple purposes for the well-being of humanity on earth. The knowledge gap in the area may be due to modernization and increased reliance on allopathic medicines.

Keywords: Native trees, urbanization, modernization, allopathic medicines

BOT-1789: Ethnobotanical Studies of Medicinal Plants of Khewra Salt Mines for Curing Skin Diseases

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Skin diseases are prevalent health concerns, particularly in regions with limited access to conventional healthcare. The Khewra Salt Mines area, known for its unique saline environment, hosts a variety of plant species that are well adapted to high salinity. This study documents the ethnopharmacological practices of local communities who utilize these plants for treating skin disorders. Comprehensive fieldwork in Village Khewra, Jhelum involved structured interviews and surveys of 200 informants, including the young, the elderly, children, and local healthcare practitioners. The current study documented 50 angiosperm species belong to 30 families, that have been used to treat a range of skin disorders like eczema, wounds, burns, pimples, ringworm, and scabies etc. The dominant families in the current study includes Asteraceae, Fabaceae (4), Rosaceae (2), and Solanaceae which are prevalent in the study areas. The different modes of administration as described by local inhabitants includes powders, pastes, decoctions, infusions, are employed in combined form with oils, milk, or ghee to boost their efficacy for treating skin disorders. Among the most frequently utilized species were *Aloe vera* L., *Melia azedarach L.*, *Mentha longifolia*, *L.*, *Pisum sativum*L., *Ziziphus jujuba* Mill., *Rosa indica* L., *Cannabis sativa* L., and *Solanum nigrum* L. These plant species have also been utilized as a source of wild fruits and vegetable to avoid wrinkles, delay aging and as natural skin tonner. The results reveal that older residents possess a richer ethnobotanical knowledge regarding utilization of plants for curing skin disorders compared to younger generations. This knowledge gap might be attributed to modernization and increased reliance on allopathic medicines. Several species also hold cultural, societal, and religious significance, notably *Allium sativum* L., *Allium cepa* L., *Justicia adhatoda* L., *Calotropis procera* (Aiton) W.T. Aiton., *Aloe barbadensis mille*r *Anethum graveolens* L., *Pseudognaphalium affine* (D. Don) Anderb., *Berberi's lyceum* Royle. Some of the species such as Drimia *indica* Roxb., *Achyranthes aspera* L., are regionally rare or endangered, reinforcing the urgent need for conservation planning, community engagement, and phytochemical validation studies. Overharvesting, grazing pressure, and habitat destruction are the major barrier leading to loss of ethnopharmacological knowledge and biodiversity in Khewra Slat mines. It is the need of time to adopt sustainable harvesting practices and engaging local communities in conservation initiatives so as to utilize this floral diversity for the well-being of humanity and to achieve sustainable development goals.

Keywords: Healthcare, Khewra Salts Mine, Sustainable, Tradition Knowledge

BOT-1782: Synergistic Effect of Selected Melia Species against Microbial Strains and Oxidative Stress.

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Medicinal plants are widely used in medical industry due to their great efficiency. Their pedigree is richer for great range of medicines. The majority of people seek treatment of various illnesses from plants. Melia azedarach is medicinally important plant. Its fresh and dried leaves, roots and seeds are used to treat wide range of problems including diarrhea, bacterial infection, burns and even cancer. *Azadirachta indica*, is also well known plant for its medical importance. This medicinal plant works well for septic pores, infectious burns, and a variety of skin and hair conditions. Leaves are advised for eczema and ulcer. The goal of current study was to investigate the synergistic action of two plants for anti-oxidant, anti-bacterial, cytotoxic, phytotoxic and phytochemical analysis. Plant extracts Phosphomolybdate assay and Anti-bacterial assay was done by using agar well diffusion method. Cytotoxic activity was checked using brine shrimp lethality assay while phytotoxic activity by radish seed germination assay. Likewise, phytochemical analysis was also done for best combination extract. For this purpose, four different combination extract of both plants were made. Plant combination 90-10 have great antioxidant activity among all having IC50 value 20.54. During Phosphomolybdate assay combination extract 90-10 have lowest IC50 value 71.63 making it strong combination extract for antioxidant activity. Strong bacterial activity in the 90-10 plant combination extract was observed against P. aeruginosa and lowest antibacterial activity against S. aureus. Cytotoxic activity was performed only on best combination extract 90-10 where LC50 value is 35.42ug/ml. Phytochemical analysis was performed on same extract shows the presence of five phytochemicals alkaloids, flavonoids, phenols, tannins and saponins. Result showed that antioxidant activity of 90-10 combination extract during all of activities one of plant combination extract 90-10 i-e 90 (Azadirachta indica), 10 (Melia azedarach) showed efficient result regarding all of activities performed. In conclusion the best-found combination is a good drug candidate and can be used in future for drug formulation and discovery.

Keywords: Melia azedarach, Azadirachta indica, Crude extract, Antioxidant activity, Anti-bacterial activity

BOT-1860: Isolation and Characterization of Growth-promoting Endophytic Bacteria from *Tribulus terrestris* L.

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Endophytic bacteria, defined as microorganisms residing asymptomatically within plant tissues, play a significant role in promoting host plant growth and enhancing tolerance to biotic and abiotic stresses. This study focused on the isolation, identification, and characterization of endophytic bacteria from the roots and stems of *Tribulus terrestris* L., a medicinal plant indigenous to the arid regions of Pakistan, with emphasis on their plant growth-promoting (PGP) traits.Twenty-four distinct bacterial endophytes were isolated. These isolates were subsequently characterised and screened for multiple PGP attributes using standard biochemical assays. Promising isolates were further evaluated for their growth-promoting potential through seed inoculation assays under controlled conditions using wheat (Triticum aestivum L.) as a model crop.The isolates demonstrated diverse PGP capabilities. Notably, all isolates exhibited phosphate-solubilising activity, quantified by halo zone diameters ranging from 4 mm to 14 mm on solid media. Partial 16S rRNA gene sequencing identified representative isolates as follows: TTR1 exhibited 99.75% similarity to Brevundimonas aurantiaca; TTR2 showed 99% similarity to Bacillus licheniformis; TTS1 shared 87.47% similarity with Bacillus; while TTS7 and TTS8 both displayed 99.76% similarity to Enterobacter cloaca and Enterobacter kobei, respectively. Inoculation with selected bacterial endophytes significantly enhanced wheat seedling growth, as evidenced by measurable increases in root length, shoot length, and overall biomass compared to uninoculated controls. These findings demonstrate the substantial PGP potential of the isolated endophytes. Consequently, these bacteria represent promising candidates for development as seed priming agents to improve crop establishment, growth, and yield, particularly in challenging environments like arid zones.

Keywords: Endophytic bacteria, Tribulus terrestris L., plant growth- promoting, Isolation, Characterization, Medicinal plants

BOT-1995: Bacterial degradation of Dye; Approaches, Mechanism, Advances and Emerging perspectives

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Synthetic dyes, being extensively applied across textile, leather, and plastic industries, have become major environmental pollutants owing to their toxicity, persistence, and resistance to conventional treatment processes. Biological methods, especially bacterial degradation, have seen growing interest as cost-

effective and environmentally friendly strategies for dye remediation. This review offers comprehensive overview of bacterial dye breakdown assays, the range of bacteria involved, types of degradation mechanism, and diverse analytical methods adopted to determine degradation of dyes. Prominent bacterial genera such as Pseudomonas, Bacillus, Acinetobacter, and Enterobacter are emphasized because of their competence in degrading azo, anthraquinone, and triphenyl methane- type dyes. The article also contrasts the performance of pure and mixed cultures, aerobic and anaerobic conditions, and the influence of environmental factors on degradation efficiency. In addition, it discusses recent developments in molecular and enzymatic tools for improving bacterial degradation. The review seeks to highlight current trends, challenges, and future directions in the development of sustainable bacterial strategies for the treatment of dye contaminated.

Keywords: Bacterial assay, pseudomonas, Aerobic, Contaminated wastewater

BOT-2063: Use of *Cannabis sativa* L. for the Management of Root-Knot Fusarium Complex in Tomato

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The tomato (*Solanum lycopersicum* L.), from the Solanaceae family, is a globally cultivated crop of significant nutritional importance, originating in South America. While Asia and Africa now account for the majority of production, the plant is also a universal host for the world's most economically damaging root-knot nematodes (*Meloidogyne* spp.), and *Fusarium*. This study investigated the efficacy of *Cannabis sativa* as a biocontrol agent for managing the synergistic disease complex caused by the root-knot nematode (*Meloidogyne incognita*) and *Fusarium oxysporum* in tomato (*Solanum lycopersicum* L.). Three controlled-environment trials simulated different infection timings: nematodes before fungus, fungus before nematodes, and simultaneous inoculation. Treatments included crushed cannabis (7.5 g and 10 g doses) and a chemical nematicide (Salibro). Results demonstrated that cannabis applications significantly reduced nematode populations (eggs and juveniles) and suppressed Fusarium wilt spread. The 10 g dose was most effective, though Salibro provided superior control, yielding the best plant growth, minimal galling and egg masses, and the lowest nematode reproduction factor (RF=0.3). Pathogenicity was confirmed in nematode-only treatments, which exhibited severe stunting and the highest infestation (RF=2.8). The findings confirm that *Cannabis sativa* possesses notable nematicidal and antifungal properties, revealing its significant potential as a sustainable, bio-based alternative for the integrated management of this economically damaging soil-borne disease complex.

Keywords: Tomato, Cannabis sativa, Root-Knot Nematodes, Fusarium, disease management

BOT-2173: Identification of Bioactive Phytochemicals, Phytochemical profiling and Evaluation of Biological Activities of *Hedera nepalensis* Fruit Extracts

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Hedera nepalensis K. Koch (family Araliaceae) is a medicinally important species traditionally used for various therapeutic purposes. The present study aimed to conduct a comprehensive investigation of the phytochemical composition, antibacterial and antioxidant potential, larvicidal and cytotoxic activities of fruit, leaf, and stem extracts of H. nepalensis. In addition, the anticancer potential and high-performance liquid chromatography (HPLC) profiling of the fruit extract were evaluated. Qualitative phytochemical screening revealed the presence of phenols, tannins, alkaloids, flavonoids, proteins, carbohydrates, cardiac glycosides, saponins, steroids, terpenoids, quinones, and coumarins. Among all extracts, the ethanol extract of the fruit exhibited the highest total flavonoid content (1.77±0.04 mg/mL) and total phenolic content (3.49±0.25 mg/mL). The same extract demonstrated the strongest antioxidant potential with the lowest IC_{50} value (23.86 µg/mL) in the DPPH assay, followed by methanol, chloroform, and aqueous extracts. Similarly, the fruit methanol extract exhibited the greatest antioxidant efficacy in the ABTS assay with an IC_{50} value of 24.24 µg/mL. Antibacterial screening indicated significant inhibitory activity of the fruit ethanol extract, producing maximum inhibition zones of 21 mm against Staphylococcus aureus and 18.5 mm against Escherichia coli. The fruit methanolic extract caused 100% larval mortality in the larvicidal assay. Cytotoxic evaluation revealed that the methanolic fruit extract exhibited pronounced anticancer activity against HeLa cells (IC_{50} = 55.17 ± 0.16 µg/mL), moderate activity against PC3 cells, and mild cytotoxicity toward 3T3 fibroblast cell lines, indicating selective cytotoxicity. HPLC analysis of the methanolic fruit extract confirmed the presence of salicylic acid (294.56 ppm) and chlorogenic acid (292.38 ppm) as major constituents, along with lower concentrations of rutin, ferulic acid, benzoic acid, gallic acid, 4-hydroxybenzoic acid, and p-coumaric acid. These findings highlight the fruit extract of H. nepalensis as a rich source of bioactive compounds with significant antioxidant, antibacterial, larvicidal, and anticancer properties. The results support its potential as a candidate for the development of novel therapeutic agents, warranting further investigation into its bioactive constituents and underlying mechanisms of action.

Keywords: Hedera Nepalensis, Phytochemical Analysis, HPLC, Antioxidant Activity, Antibacterial Activity, Cytotoxicity, Anticancer Potential

CHEMISTRY

CHE-1984: Synthesis and Characterization of Graft Copolymer for Enhanced Material Properties

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The development of graft copolymers offers a promising way to overcome the inherent limitations of conducting polymers. In present study a graft copolymer namely Chitosan graft Polyaniline synthesized via in situ chemical oxidative polymerization using ammonium per sulphate and HCL/ DBSA as an oxidant and dopant respectively with the objective of improving surface morphology and enhancing electrical conductivity of conducting polymers through increasing extend of grafting. The representative copolymer characterized using characterization techniques such as Fourier Transform Infrared Spectroscopy to confirm structural features, Scanning Electron Microscopy to examine surface morphology and Thermo gravimetric Analysis to evaluate thermal stability. To investigate electrical conductivity and charge transport behavior Impedance Spectroscopy is carried out. The results demonstrate that the grafting has significantly improved surface morphology, thermal stability and contributes to enhance conductivity compared to pristine conducting polymers. The synthesized conductive graft copolymer would be attractive in terms of its application in fabrication of electronic and sensor devices. This study highlights the effectiveness of graft copolymerization as a strategy to tailor the physicochemical and electrochemical properties of conducting polymers.

Keywords: Conducting Polymers, Graft copolymerization, Electrical Conductivity, Impedance Spectroscopy, Chi-g-PANI

Green Synthesis, Biological Potential, and Semiconducting Properties of MnO: ZnO Bimetallic Nanocomposites

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Metal-based nanoparticles offer immense potential as pharmacological agents apart from possessing interesting electrical properties. To harness these potentials, manganese oxide:zinc oxide nanoparticles were fabricated using crude extract of Curcuma zedoaria. The fabricated nanoparticles were found to be thermally stable and crystalline. Synthesized with different metal ratios, the nanocomposites exhibited significant anti-microbial and DPPH radical scavenging activities. Moreover, strong anti-leishmanial activity was shown by all the composites with IC_{50} values of 0.03, 0.14, and 4.3 µg/mL. The nanocomposites also displayed optimum energy storage and semiconducting abilities. The band gaps were found to be between 3.26 and 3.11 eV. Optimum values of dielectric constant (~ 0.95) and capacitance (~1.0 pF) were observed for MnO2:ZnO1 , while the MnO1:ZnO2

composite exhibited the best AC conductivity (1.8×10^{-9}S/m). These studies depict the potential of these nanocomposites as pharmacological agents, aswell as possessing tendency to be used as semiconducting devices.

Keywords: Bimetallic nanocomposite, Curcuma zedoaria, Anti- leishmanial activity, Anti-microbial activity, Antioxidant, Semiconductor

CHE-2015: Tailoring the antibacterial and antioxidant activities of iron nanoparticles with amino benzoic acid

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Antibacterial resistance is a massive universal health crisis and one of the most significant threats to human life. Many bacterial species have evolved and obtained resistance against multiple drugs. As a result, alternative antibacterial agents are essentially required to fight infections caused by resistant pathogenic bacteria. To study the antibacterial activity of iron nanoparticles against methicillin- resistant Staphylococcus aureus, the nanoparticles were synthesized via the microwave induced precipitation method using an aqueous solution of ferric and ferrous ions (1 : 1.5) M with sodium hydroxide (3 M). The antibacterial activity of iron nanoparticles was compared with that of copper, zinc, and chromium nanoparticles synthesized via the same approach. UV-Visible spectra show the λmax of iron nanoparticles at 287 nm. EDX spectra confirmed the absence of impurities; SEM images showed smooth morphology, while XRD diffractions revealed the crystallinity of the particles. The resultant iron nanoparticles were functionalized with p-amino benzoic acid (PABA) and anthranilic acid (AA) to enhance their antibacterial activity. Furthermore, bacteria were grown in the presence of non- functionalized and functionalized iron nanoparticles. The inhibition zones in the disc diffusion assay revealed that all the nanoparticles and alum inhibited the growth of Staphylococcus aureus, notably compared to the control samples. Furthermore, the antibacterial activity of functionalized nanoparticles was compared to that of non- functionalized nanoparticles. The result showed that anthranilic acid- functionalized iron nanoparticles (AA@Fe) are more effective against Gram-positive Staphylococcus aureus than non-functionalized nanoparticles and para-aminobenzoic acid-functionalized iron nanoparticles (PABA@Fe). In contrast to the antibacterial activity, PABA@Fe has a good antioxidant activity compared to AA@Fe.

Keywords: Antibacterial activity, antioxidant activity, Staphylococcus aureus, Iron nanoparticles

CHE-1634: Effect of *Morus alba* Mediated Bio-Amendments for Better Production of *Cicer Arietinum* (chick pea) Seeds

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The present study, green synthesis of metal oxide nanoparticles was carried out using *Morus alba* leaf extract and biochar as eco-friendly reducing and stabilizing agents. Three types of extract- mediated nanoparticles magnesium oxide (MgO), zinc oxide (ZnO), and a composite of both (Mg doped ZnO) were synthesized via the co- precipitation method. Additionally, biochar-based versions of these nanoparticles were prepared by incorporating the metal oxides onto biochar surfaces to enhance their stability, surface area, and potential plant interaction. The synthesized nanoparticles were characterized using several analytical techniques. X-ray Diffraction (XRD) was used to confirm phase purity and crystalline structure. Fourier Transform Infrared Spectroscopy (FTIR) provided insights into functional groups and confirmed the interaction of plant phytochemicals with metalions, while UV-Visible Spectroscopy helped to assess optical properties. To evaluate their biological efficacy, the materials were applied to *Cicer arietinum* (chickpea) seeds in different concentrations. Both extract-based and biochar-supported nanoparticles were tested to examine their influence on seed germination rate, root and shoot lengths, and biomass accumulation (fresh and dry weights). The effects were observed at two different time points: after 8 and 16 days for extract-based, and after 14 days for biochar-based nanoparticles. It was observed that nanoparticle treatments, particularly at moderate to higher concentrations, significantly enhanced seed germination and seedling development compared to control. Biochar-based nanoparticles showed improved moisture retention and nutrient availability, which further promoted plant growth. Statistical analysis was conducted using mean, standard deviation, germination percentage, and seed vigor index to validate the results. The study concludes that both extract and biochar-based nanoparticles have potential as sustainable growth enhancers in agriculture, offering an environmentally friendly alternative to conventional chemical treatments.

Keywords: Nanoparticles, characterization, germination, analytical analysis

CHE-1819: Biodegradation of mRNA Vaccine Byproducts in Wastewater

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The massive use of mRNA-based vaccines in various countries during the COVID-19 pandemic presented new biological substances into the environment, their durability, and their possible effect on the environment. mRNA vaccines are based on synthetic messenger RNA molecules stabilized with lipid nanoparticles (LNPs), salts, sugar, and buffer systems. As soon as unused doses, production residues, or biomedical wastes are released into a stream of wastewater, these substances are subjected to complicated physical, chemical, and biological changes. Biodegradation is a very important process that determines the fate of

such byproducts on the environment. Messenger RNA are intrinsically unstable, can be hydrolyzed quickly, and can be broken down by ubiquitous RNases found in sewage. Although lipid nanoparticles are intended to protect mRNA in vivo, they can linger longer, decomposing gradually by microbial lipid metabolism, oxidation and adsorption to sludge. Also, excipients like polyethylene glycol (PEG) derivatives are comparatively not biodegradable and can build up, however, microbial consortia within activated sludge systems have demonstrated partial biodegradable potential. It is significant to assess these processes to evaluate possible risks to aquatic life and efficiency in the treatment of the water. It has been indicated that most mRNA strands decay within hours to days under environmental circumstances, and thus bioactivity is greatly minimized. Nevertheless, there is still a concern about the persistence of LNP constituents and their relations with microbial communities. Further studies have to be conducted on monitoring the degradation kinetics, determining the microbial mechanisms involved in the degradation, and evaluation of the ecological impact over the long term. The bioavailability of mRNA vaccine byproducts through biodegradation is a crucial element to safe waste disposal and sustainable biopharmaceuticals.

Keywords: mRNA vaccines**,** Wastewater**,** Biodegradation**,** Lipid nanoparticles (LNPs), Environmental impact

CHE-1729: Pyrocatechol violet and carminic acid sensitized ZnO/CdS nanostructured photoanodes for DSSCs application

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In this study, ZnO and CdS deposited ZnO nanostructured material was successfully synthesized by using co-precipitation and ultra-sonication methods, respectively. A comparative study of the sensitization of ZnO and nanostructured ZnO/CdS with two different dyes (carminic acid and pyrocatechol violet) and applications of the synthesized material in solid state dye sensitized solar cells (DSSCs) are reported here. The characterization of the materials was performed by using x-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), UV–visible spectroscopy, and Fourier transform infrared spectroscopy (FTIR). The SEM and TEM results showed that surface of ZnO nano spheres is well covered with CdS. UV–visible spectrum showed the rise of a new optical band due to CdS deposition which effectively tuned the band gap of ZnO from 3.12 eV to 1.877 eV. XRD analysis revealed the successful formation of hexagonal phases of CdS and ZnO. The materials were applied as photoanodes in DSSCs with and without dye sensitization. P3HT (Poly (3-hexylthiophene) was used as a hole conducting polymer. CdS deposition and sensitization with different dyes showed a significant effect on the overall efficiency of fabricated devices. The ZnO/CdS based DSSC sensitized with carminic acid showed a current density (Jsc) of 8.72 mA/cm^2 with an open circuit voltage (Voc) of 0.43 V and an overall efficiency of 1.42%. While the same

photoanode material sensitized with pyrocatechol violet gave Jsc value of 9.13 mA/cm^2 with a Voc of 0.39 V and an overall efficiency of 1.55.

Keywords: ZnO/CdS nanostructures, dye-sensitized solar cells, band gap tuning, carminic acid, pyrocatechol violet

CHE-1935: Potential of Carbon Smart Hydrogen Production from Waste Edible Oil (WEO) in Pakistan – From Fryer to Fuel

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Pakistan's energy sector is challenged by heavy reliance on imported fossil fuels and poor waste management practices. Among the available waste streams, waste edible oil (WEO) offers significant potential as a renewable feedstock for clean energy. National edible oil consumption exceeds 4 million tonnes per year, with nearly 10% (~400,000 tonnes) estimated as recoverable WEO. In Punjab alone, generation levels are reported at roughly 500,000 litres per day (equivalent to ~182,000 tonnes annually). This work investigates the direct catalytic steam reforming of WEO to produce carbon smart hydrogen, avoiding the conventional biodiesel route. The process involves reforming triglyceride- and FFA-rich WEO over a Ni/Al_2O_3 catalyst at 800–850 °C, generating syngas that undergoes water–gas shift conversion and subsequent purification via membrane separation and pressure swing adsorption (PSA), yielding hydrogen of 99.9% purity. The recovered PSA tail gas with H_2, CO and CH_4 mix provides process heating, enhancing thermal efficiency. Based on an average yield of 0.1 tonne of hydrogen per tonne of WEO, Pakistan's annual WEO availability could support production of around 40,000 tonnes of hydrogen. Such capacity would make a meaningful contribution to industrial energy supply while reducing fossil fuel imports. Compared with electrolysis, WEO reforming represents a more cost-effective and immediately deployable option, while advancing circular economy principles by transforming waste into clean fuel. The proposed approach supports Pakistan's low-carbon transition strategy, delivering both environmental and economic advantages for developing economies.

Keywords: Waste edible oil, catalytic steam reforming, carbon-smart hydrogen, pressure swing adsorption

CHE-1939: Synthesis of Functionalized Chalcone and its Derivatives for Biological Applications

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In this study, a series of variably substituted chalcones and their corresponding oxime derivatives were successfully synthesized and characterized. Structural elucidation of the synthesized compounds was carried out using IR and UV spectroscopic techniques. Molecular docking studies were performed to assess their potential inhibitory activities against acetylcholinesterase (AChE) and butyrylcholinesterase (BuChE). These preliminary findings support further investigation, and in vitro biological evaluations of the compounds are planned for future studies.

Keywords: Chalcones, Oxime derivatives, Alzheimer, Acetylcholinesterase (AChE), butyrylcholinesterase (BChE)

Biomass Synthesized Materials and Their Bioactive Compound Detection

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Modern drug delivery research is mainly highlight on liposomal method because they enhance drug solubility and ensure targeted delivery. This study focuses simple method of liposomal encapsulation which is useful for rising drug availability and lead to better therapeutic results. Herbal medicines are also being embraced into advanced delivery systems. This approach constructively blend conventional medicine with modern nanocarrier technology. Cancer is growing very fast, and becoming cause of death in many countries. Attentive and substitute is required in this aspect of treatment. Remedial plants like tribulus terrestris, moringa and goose berry are widely known for their medicinal purposes, especially in their potential as an anticancer, anti-hypertension, anti-diabetic, and cardiovascular issues. This present paper reviews the various risk factors associated with anticancer, anti-hypertension etc while it explored the action of these herbs as phytotherapy. It involves phytochemical constituents, techniques and their effectiveness regarding treating cancer, hypertension and cardiovascular issues. The future prompt agenda is presenting the improved traditional curative treatments to heal patients of cancer, hypertension, diabetes etc.

Keywords: Liposome, Herbal medicine, Tribulus terrestris, Moringa, Goose Beery, Anticancer, Anti-hypertension, Phytochemical constituents

CHE-1732: Lanthanum- and Yttrium-Doped NMC811 as Stable Cathode Materials for Lithium-Ion Batteries

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The pristine $LiNi_{0.8}Mn_{0.1}Co_{0.1}O_2$ (NMC 811) and doped variants, $LiNi_{0.8-x}Co_{0.1}Mn_{0.1}O_2$ (x = 0.01, 0.1, and 0.2) incorporating La^{3+} and Y^{3+}, were successfully synthesized via continuous hydrothermal flow synthesis (CHFS). This study demonstrates an effective doping strategy to enhance the structural integrity of NMC 811. X-ray diffraction (XRD) analysis revealed that calcination at 850 °C for 12 h with a 3-fold lithium excess (1.6–2 g Li precursor per 2 g NMC powder) provided optimized conditions for a structurally stable phase.The incorporation of La^{3+} and Y^{3+} significantly improved both the structural robustness and cycling stability of the cathode material. The influence of dopants on the crystallographic, morphological, and electrochemical behavior was systematically investigated using XRD, EDX, SEM, cyclic voltammetry (CV), and galvanostatic charge– discharge studies. Pristine NMC 811 exhibited a relatively low discharge capacity (~130 mAh g^{-1}), which degraded rapidly due to structural collapse, side reactions, and cation disorder. In contrast, doped materials demonstrated enhanced discharge capacity and improved cycling stability, with performance depending on the type and concentration of dopant. Among the samples, La^{3+} doping delivered the most pronounced enhancement, with 2% La^{3+}h achieving ~170 mAh g^{-1}. The improvement is attributed to the electrochemical activity of La^{3+}, which reduced electrode polarization and facilitated Li^+ diffusion. Conversely, Y^{3+}-doped samples exhibited lower discharge capacity (~135 mAh g^{-1} at 0.1% Y^{3+}), a result ascribed to the electrochemically inert nature of Y^{3+}. Nonetheless, Y^{3+} improved structural stability by suppressing degradation processes. Overall, this work highlights that the role of dopants in NMC cathodes is highly dependent on their structural and electrochemical characteristics. The findings provide a generalizable strategy for stabilizing layered oxides and improving the electrochemical performance of cathode materials in lithium-ion batteries.

Keywords: NMC811, Cathode materials, Lithium-ion batteries, Rare- earth doping, Lanthanum doping, Yttrium doping, Structural stability, Electrochemical performance, cycling stability, Charge–discharge capacity, Cation disorder suppression, Li-ion diffusion

CHE-1663: Bio-Derived Polymeric Films with Natural Additives for biomedical Applications

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In this work, polymeric films were prepared using renewable and biodegradable materials and combined with natural additives to improve their performance. The

addition of bioactive compounds that carry antioxidant and moisture-retaining properties is expected to enhance the overall functionality of the films. These bio-based films provide an eco-friendly option compared to synthetic materials and can help reduce environmental impact while offering reliable protection and stability. The study highlights the importance of sustainable materials in creating useful films with both environmental and functional benefits.

Keywords: Biobased Films, Natural Additives, Sustainable Materials, Ecofreindly Polymers

Fabrication of 5% Fe doped CuS Nanoparticles for photocatalytic degradation of Congo Red

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Water pollution caused by toxic dyes poses significant threats to both the environment and human health. Among various treatment techniques, photocatalysis has emerged as an effective and sustainable method for dye degradation. In this study, 5% iron-doped copper sulfide (CuS) nanoparticles were synthesized and employed as photocatalyst due to their favorable optical and electronic properties. The synthesis involved a two-step process: first, the preparation of a single-source precursor, Cu(II) dithiocarbamate complex; followed by the formation of nanoparticles via a solvothermal method using ethylenediamine as decomposing solvents. The structural and compositional properties of the synthesized nanoparticles were characterized using XRD, SEM, EDX, and UV-Vis spectroscopy. EDX confirmed the elemental composition, while SEM images revealed spherical nanoparticles with sizes ranging between 100 and 200 nm. XRD analysis indicated high crystallinity and phase purity. UV-Vis absorption showed a distinct peak at ~300 nm, corresponding to the band-to-band transition of CuS. The photocatalytic performance was evaluated by degrading Congo red dye under visible light. The results demonstrated nearly 100% dye degradation within 65 minutes without H_2O_2, and within 35 minutes when H_2O_2 was added. The degradation process followed pseudo-first-order kinetics, confirming the catalytic efficiency of the Fe-doped CuS nanoparticles.

Keywords: Congo red, Nanoparticles, Photocatalyst, Solvothermal, kinetics

CHE-1854: Synthesis, *in vitro* biological screening, and DFT study of potentially bioactive zinc (II) Complexes with *O*-Donor Ligands

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Metal complexes with bioactive ligands have gained increasing attention due to their promising roles in pharmaceutical and biomedical applications. In this study, a series of zinc(II) complexes were synthesized using phenolic ligands including salicylic acid, hydroquinone, α-naphthol, β-naphthol, curcumin, and resorcinol, through a straightforward reflux method in ethanol with a metal-to- ligand ratio

of 1:2. The resulting complexes were obtained as stable, colored solids in moderate to good yields. Characterization was performed using melting point, and FT-IR spectroscopy, elemental analysis, and AAS, which confirmed coordination through oxygen donor atoms with the disappearance of characteristic hydroxyl peaks in most complexes and the emergence of Zn–O stretching vibrations. The quantum mechanical parameters such as the energy of the frontier molecular orbitals (EHOMO and ELUMO), and the Mulliken charge distribution on the optimized structures was determined using a DFT/B3LYP method combined with the 6-31G(d,p) basis set in the gas phase. Antibacterial activities were evaluated against Staphylococcus aureus, Salmonella typhimurium, Micrococcus luteus, Bordetella bronchiseptica, and Enterobacter aerogenes using the agar well diffusion protocol. All complexes displayed moderate to significant antibacterial effects, with zinc–salicylic acid and zinc–curcumin complexes showing the highest inhibition zones (17–20 mm), particularly against Gram-positive strains. These results suggest that complexation enhances the intrinsic activity of ligands by improving lipophilicity, membrane permeability, and bioavailability, consistent with chelation theory. Overall, this study demonstrates that simple zinc–phenolic complexes can serve as potential antimicrobial agents and provides a basis for future exploration into ligand modification, mechanistic studies, and possible pharmaceutical applications.

Keywords: Zinc(II), Complexes, Phenolic, Ligands,, Curcumin, Antimicrobial Activity, FTIR Spectroscopy, DFT

CHE-1711: Development of fast Dissolving Encapsulated Oral Films and Approach for Their Therapeutic Application

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Diabetes mellitus is a metabolic disorder which is characterized by high blood sugar level resulting direct from insulin resistance, inadequate insulin secretion or excess glucagon secretion. Conventional treatments face limitations such as low bioavailability and poor absorption. Green synthesis offers environmentally friendly approach to produce nanoparticles which avoid harmful chemicals and enhance therapeutic potential of bioactive plant. Lipid nanoparticles are nano sized carries with amphiphilic properties, enabling the encapsulation of a wide range of substances. Their biologically inertness and biodegradability make them applicable in medicine, cosmetics, food and industry. Herbal plant Tribulus terrestris contains bioactive compounds which have been used extensively for medicinal purpose like anti-inflammatory, antidiabetic and testosterone booster. The present work aimed biosynthesis of nanoparticles using Tribulus plant extract and incorporating then into thin films of fast dissolving strips to enhance its stability and bioavailability. Tribulus plant extract was prepared and encapsulated into thin films. The prepared strips were evaluated for different properties like thickness, uniformity and stability. The results were characterized using UV XRD. The thin films exhibited nano scale particle size, good stability and high

efficiency. Green synthesized fast dissolving thin strips of Tribulus terrestris are eco-friendly and effective for diabetes.

Keywords: Green synthesis, herbal plant, thin films, nanoparticles, antidiabetic

CHE-1871: Modeling and Performance Optimization of Barium Antimonide Tri-Iodide (Ba3SbI3) Optical Absorber Based Solar Cell

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This study presents a numerical investigation and performance optimization of a lead-free, inorganic perovskite-based solar cell employing Barium Antimonide Tri-Iodide (Ba_3SbI_3) as the absorber layer. Using the SCAPS-1D simulation tool, a solar cell architecture ITO/ZrO_2/Ba_3SbI_3/PTAA/Au was developed comprising ZrO_2 as the electron transport layer (ETL), Ba_3SbI_3 as the absorber, and PTAA as the hole transport layer (HTL) was modeled under standard illumination conditions (AM1.5G, 1000 W/m², 300 K). The cell was simulated for a frequency of 1×10^6 Hz, with a quantum efficiency (QE) approaching near 100% across the ultraviolet, visible, and infrared regions, indicating excellent photon harvesting capabilities. The simulation was conducted using literature-sourced material parameters, including band gap energies, carrier mobility, doping concentrations, and interface properties. The primary variable in this study was the thickness of each layer (ETL, absorber, and HTL), which was systematically optimized to assess its influence on device performance. The final optimized configuration used thicknesses of 0.011 µm for ZrO_2, 0.868 µm for Ba_3SbI_3, and 0.316 µm for PTAA. According to reported material parameters Ba_3SbI_3 exhibited favorable optical and electronic characteristics with a high dielectric constant, moderate band gap, and low defect density, enhancing charge separation and reducing recombination losses. The combination of high electron mobility in ZrO_2 (100 cm²/Vs), optimal hole mobility in PTAA (40 cm²/Vs), and suitable energy band alignment enabled efficient charge transport and extraction. The optimized device architecture demonstrated significant potential with high predicted performance metrics, confirming Ba_3SbI_3's viability as a sustainable and efficient absorber for future generation photovoltaic applications. The device displayed a V_{OC} of 0.5504 V, J_{SC} of 54.452 mA/cm^2, FF of 79.09%, and PCE of 23.711%. This work provides a foundation for further experimental validation and the future integration of Ba_3SbI_3-based solar cells into scalable, lead-free photovoltaic technologies.

Keywords: Ba3SbI3 (Absorber), SCAPS-1D, Solar Cell, ZrO_2 (ETL), PTAA (HTL)

ZOOLOGY

ZOO-1684: Comparative Study of Antimicrobial Effect of Honey and Antibiotics on Pathogens

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Three different fresh honey samples of various botanical origins classified as *Eucalyptus*, *Citrus* and Sider (*Zizipus jojoba*) were used and collected directly from the beekeepers with the aim to compare and evaluate the antimicrobial effects of honey and antibiotics against *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*) bacteria of clinical significance. These bacterial strains were acquired from the Microbiology laboratory, National University of Medical Sciences, Rawalpindi. Cefuroxime (CXM) effect was seen against the bacterial strains. Physical parameters of honey, assessment of antibacterial activity of honey by agar well diffusion method and Minimum Inhibitory Concentration (MIC) was determined. Synergistic activity of honey and antibiotic (Cefuroxime 30 µg) against bacterial strains was also carried out. All testing was carried out in triplicate to provide more reliable and reproducible data. The results demonstrated that all honey types exhibited measureable antimicrobial activity against both pathogens. Cefuroxime showed synergistic effect with honey types i-e *Eucalyptus*, *Citrus* and Sider at 50 %, 75 % and 100 % against *S. aureus* and *E. coli*. However, *S. aureus* was found more sensitive against Cefuroxime exhibiting average zone of inhibition of 10.4 mm than *E. coli* (7.25 mm).

Keywords: antimicrobial effects, Escherichia coli, Staphylococcus aureus, honey, Cefuroxime

ZOO-1761: Proximate composition of *Cirrhinus mrigala* muscle tissue by habitat and body weight

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Cirrhinus mrigala is one of the most important freshwater carps of South Asia, valued for its rapid growth, high market demand, and rich nutritional profile, making it a key species in aquaculture and inland fisheries. The present study was designed to assess the effect of habitat and body weight on the proximate composition of *C. mrigala*. Fish samples (n=16) were collected from farm and riverine environments. The samples were further divided by body weight into two categories (1–2 kg and >2 kg). The samples were analyzed using standard Association of Official Analytical Chemists (AOAC) methodologies. Moisture, dry matter, and ash contents were determined by oven-drying and muffle furnace incineration, crude protein was estimated by the Kjeldahl method, and crude fat was analyzed using the Soxhlet extraction method. Results of the present study suggested that farm-raised fish exhibited significantly higher dry matter content

than riverine fish. Moreover, fish species with >2 kg body weight have greater dry matter content compared to smaller ones with 1–2 kg body weight. Moisture content, however, was consistently higher in river- raised fish than in farm-raised fish. Ash content was significantly affected by both habitat and body size. Riverine fish with >2 kg body weight exhibited higher ash levels compared to smaller riverine fish. Riverine habitats also supported significantly higher protein content. Fat composition highlighted the nutritional advantage of *C. mrigala*. Riverine *C. mrigala* with >2 kg body weight accumulated significantly more fat compared to farm-raised fish of the same weight. In conclusion the proximate composition of *C. mrigala* was affected by both habitat and body weight. Riverine habitats promoted higher protein, ash, and fat levels, particularly in larger fish, whereas farm- raised environments supported higher dry matter content. These findings suggested that *C. mrigala* possesses superior nutritional qualities in natural habitats, with larger fish species offering the highest consumer value.

Keywords: Cirrhinus mrigala, proximate analysis, aquaculture nutrition, habitat variation, fish body weight

ZOO-1973: *In-Silico* Identification of Potential Phytochemical Inhibitors Targeting Ubiquitin Conjugating Enzyme E2N (UBE2N) Involved in Prostate Cancer

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Prostate cancer (PCa) remains a major cause of cancer- related mortality among men worldwide, with overexpression of the UBE2N gene strongly associated with disease progression. Targeting UBE2N has emerged as a promising strategy to enhance PCa treatment outcomes. In this study, we applied *in-silico* approaches to explore the potential of phytochemicals as inhibitors of UBE2N. Molecular docking was performed to evaluate binding affinities between selected phytochemicals and the UBE2N protein, while ADMET analysis assessed pharmacokinetic and toxicity profiles to determine drug- likeness. To validate the results, NSC697923, a well-established UBE2N inhibitor with anti-cancer activity, was used as a reference molecule. Docking confirmed its strong interaction with UBE2N, serving as a benchmark for comparison. Among the tested phytochemicals,6-methoxy-3-(4-methoxyphenyl)-7 [(2S,3R,4S,5S,6R)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-yl] oxychromen-4-one demonstrated the most favorable binding energy and pharmacological properties suggesting its potential as a therapeutic lead compound. These findings emphasize the value of *in- silico* screening in identifying novel drug candidates and highlight the need for further in vitro and in vivo studies to confirm the therapeutic potential of phytochemicals in targeting UBE2N-driven prostate cancer.

Keywords: Prostate cancer, UBE2N, phytochemicals, Molecular Docking

ZOO-1776: Outcomes of Trabeculectomy – A Single Surgeon, Single Center Experience from Rawalpindi, Pakistan

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Trabeculectomy was introduced by Cairns in 1968 and remains the most commonly performed procedure for the treatment of medically uncontrolled glaucoma. Primary trabeculectomy was defined as the first intraoperative glaucoma operation performed on the eye. Trabeculectomy is still regarded as the gold-standard glaucoma operation. To achieve a better understanding of the outcomes of trabeculectomy, we conducted a cross-sectional audit of the current performance of primary trabeculectomies at Al Shifa Trust Eye Hospital, Rawalpindi, Pakistan. All primary trabeculectomies (n = 48) performed by a single surgeon at our center from Oct 4, 2021 to Oct9, 2022 were included. Fornix based with antimetabolite technique was used. Data of Visual acuity, IOP and the number of drugs the patients were on, was collected preoperatively and then at 2 weeks, 1 month, 3 months, 6 months and 1 year. Complete success was achieved in 71% of the cases. At 1 year, visual acuity remained static in 21/48 (43%), worsened in 15/48 (31%), while 12/48 (25%) were lost to follow up. 12 out of the 15 patients, in whom the vision worsened had 6/36 or worse vision to begin with. Most patients in whom the vision deteriorated at 1 year, they had a poor Pre Op vision. The decrease in the vision at Day 14 is expected as this is primarily due to the astigmatism caused by the trabeculectomy sutures and the use of cycloplegics.

Keywords: Trabeculectomy, Al Shifa Trust Eye Hospital, vision, glaucoma

ZOO-2066: Microwave-Assisted DNA Extraction from Archived Formalin- Fixed Parafin-Embedded Liver Tissue of Mice (Mus musculus)

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Formalin-fixed parafin-embedded (FFPE) tissues are widely applied for research purposes, including retrospective and prospective studies. In molecular oncology diagnostics, a key requirement is the extraction of high-quality genomic DNA. The current research aimed to extract DNA from five years ago preserved FFPE liver samples of albino mice (Mus musculus) utilizing readily available kitchen ingredients. The FFPE tissue samples were collected from the Department of Zoology Laboratory, University of Okara (UO). DNA was isolated after many attempts from identical replicates of FFPE liver tissues samples. DNA extracted from FFPE liver tissues was evaluated using NanoDrop, yielding concentrations of 14.05µg/ml, 13.05µg/ml, and 6.450µg/ml. The corresponding purity ratios at

A260/280 were 1.734, 1.933, and 1.870, indicating variable DNA quality across the samples. In conclusion, this study demonstrates the successful recovery of DNA from long-term preserved FFPE tissues using cost-effective and easily accessible reagents. The proposed method provides a practical strategy for laboratories operating under resource constraints and highlights the potential of archived FFPE samples as a valuable source for molecular research and oncology diagnostics.

Keywords: DNA, Mus musculus, Formalin-fixed parafin-embedded, extracted

ZOO-1749: A Study on Effect of Type 2 Diabetes Mellitus on Serum Vitamin A Levels in Patients from Rawalpindi and Azad Jammu & Kashmir

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Diabetes Mellitus is a chronic metabolic condition resulting from abnormalities in insulin signaling, secretion or both, leading to symptoms such as high blood sugar and disruptions in fat, protein and carbohydrate metabolism. Vitamin A could potentially influence the secretion of insulin. Insufficient levels of vitamin A over an extended period may result in decreased hormone levels in the pancreas. Presence of vitamin A affects cell development, including pancreatic cells, which is advantageous for insulin synthesis. Research on animals has shown that the deficiency of vitamin A may lead to a reduction in pancreatic β-cell mass and decreased insulin secretion, ultimately causing hyperglycemia as a result of triggered β-cell apoptosis. Current study was carried out to estimate vitamin A level in diabetic patients from Rawalpindi and Azad Jammu and Kashmir (Rawalakot). About 100 diabetic patients with 100 age matched healthy control were selected. Inclusion criteria for the patients were: consent to participate in the study, no physiological abnormality and for female patients, not currently pregnant or lactating. Serum samples were collected from the blood of all the selected subjects. Blood glucose level and HbA1c were collected from patients reports. Vitamin A level was estimated through the ELISA technique. Vitamin A was lower in the diabetic patients. The mean of diabetic patients was 263.07 ± 19.67 and the control subjects was 342.05 ± 38.75. The significant difference was 0.036 ng/ml. There was a significant difference in the vitamin A levels of diabetic patients based on location ($p < 0.01$), age ($p < 0.00$), diabetes duration ($p < 0.00$), HbA1c ($p < 0.00$) and vegetable consumption ($p < 0.00$) and had a positive correlation with location, occupation, sunlight exposure, symptoms of diabetes, vitamin A deficiency signs, taking any medication for diabetes, taking any vitamins, exercise, vegetable consumption, dairy consumption. Vitamin A was lower in the residents of Rawalpindi (251.65 ± 38.64) than in Azad Jammu and Kashmir (272.21 ± 21.23).

Keywords: Diabetes mellitus, Vitamin A, β cells, insulin, HbA1c, Rawalpindi, Azad Jammu & Kashmir