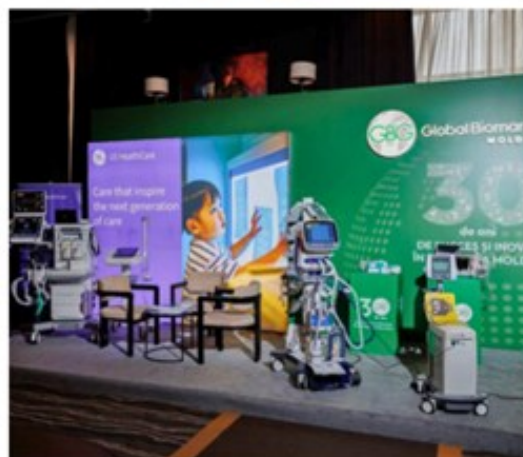
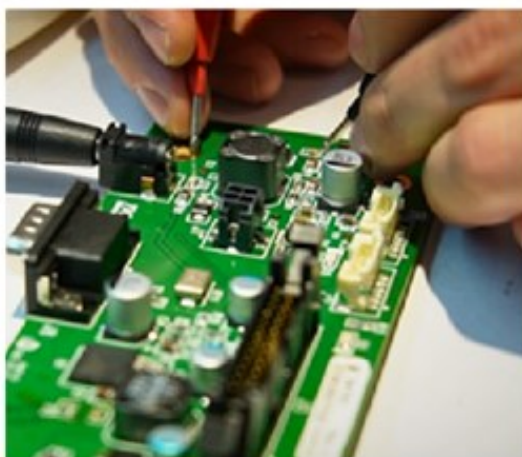


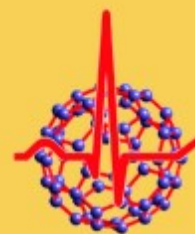


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ICNBME-2025

7th International Conference
on Nanotechnologies and
Biomedical Engineering



7th INTERNATIONAL CONFERENCE on Nanotechnologies and Biomedical Engineering

Abstract Book

Cisinau, Moldova
October 7-10, 2025

ICNBME-2025 Program at a Glance

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	8 ³⁰ -9 ³⁰	Registration, Distribution of the Conference materials (Technical University of Moldova, Stefan cel Mare av., 168, Chisinau)	
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	11 ³⁰ -11 ⁵⁰	11:30 - 11:50 COFFEE BREAK	
	11 ⁵⁰ -12 ³⁰	PLENARY SESSION PL-1 <i>Ashok Vaseashta</i>	
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	15 ³⁰ -16 ⁰⁰	15:30 - 16:00 COFFEE BREAK	
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	14 ⁰⁰ -15 ³⁰	SECTION S1-2 Nanotechnologies and Nanomaterials Room 4	SECTION S8-1 Medical physics & biophysics Room 5
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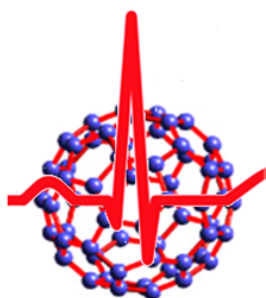


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7th INTERNATIONAL CONFERENCE on Nanotechnologies and Biomedical Engineering

October 7-10, 2025, Chisinau, Republic of Moldova

Abstract Book



ICNBME - 2025

**7th INTERNATIONAL CONFERENCE
on Nanotechnologies and
Biomedical Engineering**

Organized by:

*Moldovan Biomedical Engineering Society
Technical University of Moldova
Academy of Sciences of Moldova*

In collaboration with:

*Nicolae Testemitanu State Medical and Pharmaceutical University
International Federation for Medical and Biological Engineering
European Alliance for Medical and Biological Engineering & Science*



CZU 61:[57+620.3](082)

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Published by: **Technical University of Moldova**

Editors: **Prof., Dr. Victor Sontea,**
Acad., Prof., Dr. habil. Ion Tiginyanu
Dr. Serghei Railean

DESCRIEREA CIP A CAMEREI NAȚIONALE A CĂRȚII DIN REPUBLICA MOLDOVA

"Nanotechnologies and Biomedical Engineering", international conference (7 ; 2025; Chișinău). 7th International Conference on Nanotechnologies and Biomedical Engineering: ICNBME-2025, October 7-10, 2025, Chisinau: Abstract Book / editors: Victor Sontea [et al.]; conference chairmen: Victor Sontea, Ion Tiginyanu. – [Chișinău]: [S. n.], 2025 (Service-Eurotipar). – 158 p.: fig. color.

Antetit.: Moldovan Biomedical Engineering Society [et al.]. – Referințe bibliogr. la sfârșitul art. – Index: p. 148-153. – With the financial support of the Technical University of Moldova [et al.]. – [200] ex.

ISBN 978-5-86654-533-9.

61:[57+620.3](082)

N 20

ISBN 978-5-86654-533-9

Editura SERVICE-EUROTIPAR 2025

Tipar executat la tipografia SERVICE-EUROTIPAR

str. Măria Lătărețu 32 • Tel: 068 595 595

eurotipar@gmail.com

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7th International Conference *Nanotechnologies and Biomedical Engineering*

Organized by

- **Moldovan Biomedical Engineering Society**
- **Technical University of Moldova**
- **Academy of Sciences of Moldova**

In collaboration with

- **Nicolae Testemitanu State University of Medicine and Pharmacy of the Republic of Moldova**
- **International Federation for Medical and Biological Engineering**
- **European Alliance for Medical and Biological Engineering & Science**

Information Note

ICNBME-2025 continues the series of International Conferences in the field of nanotechnologies and biomedical engineering. The conference aims at bringing together scientists and engineers dealing with fundamental and applied research for reporting on the latest theoretical developments and applications in the fields involved.

The Conference details are available on the website <https://icnbme.sibm.md>

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The Organizing Committee of the **7th International Conference on Nanotechnologies and Biomedical Engineering** highly appreciates the financial and technical support provided by the following institutions, agencies and enterprises:

- **Technical University of Moldova**
- **Moldovan Biomedical Engineering Society**
- **Ministry of Education and Research of the Republic of Moldova, Institutional subprogram #02.04.02 ETISEL**
- **International Federation for Medical and Biological Engineering (IFMBE)**
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PREFACE

It is our great pleasure to welcome all participants to the 7th International Conference on Nanotechnologies and Biomedical Engineering (ICNBME), to be held on October 7-10, 2025, in Chisinau, Republic of Moldova. ICNBME-2025 continues the series of international conferences in the field of nanotechnologies and biomedical engineering with the main objective of bringing together scientists and engineers dealing with both fundamental and applied research, and to provide a platform for presenting the latest theoretical developments and applications in the fields involved.

The conference covers a wide range of topics of primary importance for research and development, including Nanotechnologies and Nanomaterials, Biomaterials and Devices for Medical Applications, Bioinstrumentation, Signal and Image Processing, New Technologies for Personalized Medicine, Bioinformatics, E-health and Telemedicine, Bioengineering in Oral Health, Regenerative Medicine and Tissue Engineering, Medical Physics and Biophysics, Interdisciplinary Research for Medicine.

The contributions of the Conference reflect the results of multidisciplinary research undertaken by about one hundred of worldwide groups. Special attention is paid to the development of novel nanotechnologies and nanomaterials, in particular of bio-nanotechnologies and bio-nanomaterials. New biocompatible materials are proposed for applications in regenerative medicine, cellular and tissue engineering. Valuable data are also reported on novel chemical and biosensors based on nanostructured metal oxides and hybrid nanocomposite materials. New theoretical and experimental results are highlighted in such fields as metamaterials, aeromaterials, micro-opto-electronic and photonic materials, photovoltaic structures, quantum dots, one- and two-dimensional nanomaterials, 3D nanoarchitectures, multifunctional hybrid materials like sandwich and core-shell structures, etc.

The conference sessions also present high-quality research contributions addressing current challenges and innovations in biomedical engineering. The included works explore advanced technologies for medical imaging, therapeutic systems, rehabilitation devices, and diagnostic tools, reflecting the rapid progress in engineering solutions for healthcare. A wide range of new technologies for diagnosis, personalized approaches in medicine are also presented. Considerable progress has been achieved at the intersection of nanotechnologies, information technologies and biomedicine as, for example, in health informatics, e-health, telemedicine, biomedical instrumentation and signal processing. By encouraging interdisciplinary approaches, this volume promotes the development of integrated and patient-centered technologies. Key topics include genetic and biomarker-based diagnostics, predictive modeling of disease progression, and computational simulations of biological systems. Several studies explore artificial intelligence applications in healthcare, with a focus on data security, patient stratification, and decision support systems.

We hope that the papers scheduled to be presented at the Conference will be of interest for established researchers working in multidisciplinary fields of science and technology, to young scientists and students, as well as to the broader community wishing to obtain up-to-date information on progress in the fast-developing areas of nanotechnology and biomedical engineering.

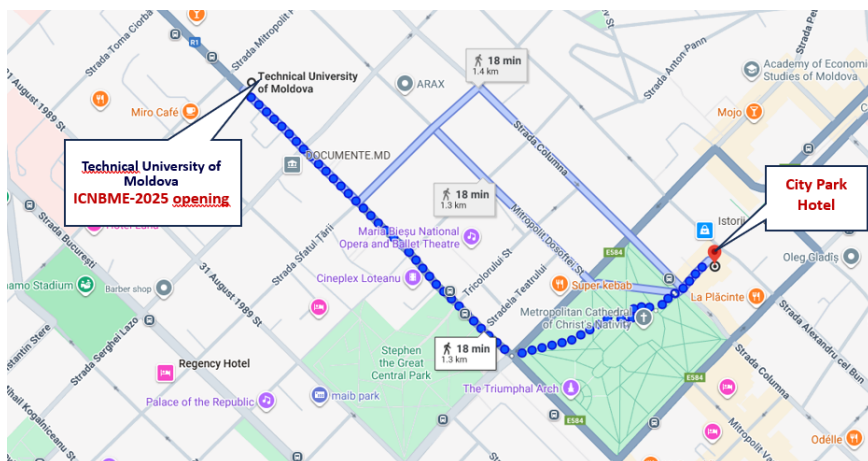
We gratefully acknowledge the support of the Scientific Committee, the Local Organizing Committee, and all reviewers for their efforts in ensuring the scientific quality of the conference. We also thank the sponsors and partner institutions for their valuable contribution.

Prof. Victor SONTEA, Acad. Prof. Ion TIGINYANU
Chairmen

Chisinau, Republic of Moldova, October 2025

Participant's registration will take place at the Technical University of Moldova, Magna Hall, block #1, Stefan cel Mare si Sfanta boulevard 168, Chisinau, Republic of Moldova, on October 6th from 10.00 to 19.00 and October 7th from 8.30 to 10.00.

The Conference opening will take place at 9.30, October 7th, 2025 in the Magna Hall of the Technical University of Moldova.



The Conference will take place at the Labour Institute located on Zimbrului street, 10, Chisinau, Republic of Moldova. The building is located in the park area between two city districts: Rishkani and Chekani.



Language

The official language of the Conference is **English**.

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- Ion Tiginyanu President of the Academy of Sciences of Moldova, Republic of Moldova

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PRESENTING AUTHORS INSTRUCTIONS

Oral Presentations:

1. Please make your presence known to one of the chairmen 5 minutes before your session starts and be present during the entire session in which your presentation is scheduled. Time slot for plenary sessions is up to 90 minutes.
2. Time slots for oral sessions are 90 minutes. Number of papers in each session is up to 6 meaning that 15 minutes is allocated for each presentation (20 minutes for invited presentations). However, there are exceptions to this rule; therefore, please refer to the final program for actual duration of your presentation.
3. Authors and Speakers must report to the Speakers Area in order to preview and upload their presentations. Files must be handed-in a minimum of 2 hours prior to the start of their session (for morning sessions starting at 9.00 h, please upload it the day before). We recommend that you take advantage of the early file uploading opportunity. More details are available at the conference web site <https://icnbme.sibm.md>.
4. All session rooms will be equipped with a data projector and a computer. You do not need to bring your own laptop to the lecture room. Please prepare your presentations for display with aspect ratio 4:3.
5. When building your presentation, use standard fonts (e.g., Times New Roman, Arial, etc.). Basic fonts are included on the session room computers, but if an unusual font is used it may not display well.
6. Even if you have submitted your presentation files in advance, please plan to bring the latest version of your presentation to the session on a Windows-readable USB flash Drive or CD-ROM.
7. Computers in conference rooms are equipped with Windows 10, Microsoft Office 2016 package. Apple Mac computers will not be provided in any of the session rooms. If you are using Mac, please check compatibility with Microsoft Office 2010 package or use your own Mac computer if your presentation is created in Apple's "Keynote" presentation application. Videos handed in as an independent file must be coded under standard codec. Users are recommended to preview them in standard universal software, such as VLC Player or Quicktime.

Posters:

Poster sessions are a valuable method for authors to present papers and meet with interested attendees for in-depth technical discussions. Therefore, it is important that you display your results clearly to attract people who are interested in your work and your paper. Your poster should cover the KEY POINTS of your work. The ideal poster is designed to: attract attention; provide a brief overview of your work; initiate discussion and questions.

Use colors to highlight and make your poster more attractive, by using pictures, diagrams, cartoons, figures, etc., rather than only text wherever possible. There is however no specific template for the poster: font size and text are free.

Maximum outside dimensions of each poster, including the title, must not exceed 60 cm width x 84 cm height (A1 sheet).

SET UP AND DISMANTLING TIMES:

A poster number display will be placed at the top corner of the board. Double sided tape will be supplied at each poster board.

Poster sessions will be held on Thursday 9 October according to the program.

Poster set up time: 10:40-11:10 h. Authors are requested to be next to their posters during poster session: 11:10-13:00 h.

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S2 - Biomaterials and devices for medical applications

S3 - Bioinstrumentation, signal and image processing

S4 - New technologies for personalized medicine

S5 - Bioinformatics, e-health and telemedicine

S6 - Bioengineering in oral health

S7 - Regenerative medicine and tissue engineering

S8 - Medical physics & biophysics

S9 - Interdisciplinary research for medicine

**YIC - YOUNG INVESTIGATORS COMPETITION -
Nanotechnologies and Biomedical Engineering**

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Plenary Speakers Abstracts

PL-1.3 Leveraging AI Innovation in Nanomaterial Synthesis and Device Design

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Artificial intelligence (AI) based innovations in materials science are poised to transform traditional research paradigms, ushering in a new era of accelerated discovery. Using generative AI, the scientific disciplines are at an inflection point as researchers seek to establish how this evolutionary technological leap can be most practically integrated into our ongoing research. Combining hypothesis- and data-driven approaches, unlocking deeper insights into complex structure-property relationships is possible. Furthermore, conjoining machine learning and materials selection, optimization of synthesis parameters, and characterization analysis are accelerating material designs deemed unrealistic earlier. Thus, AI has emerged as a fundamental tool in various research domains, fostering innovative research that advances this transformative tool in multiple fields. Specifically for materials synthesis, device design, and system integration, the AI-assisted tools reimagine how they design and understand functional materials. The field continuously expands with an in-depth understanding of the classification of material properties at the nanoscale, theoretical approaches and simulations in nanoscience, design considerations of nanodevices, and material synthesis at the nanoscale with controlled morphology. This has led to the development of size- and shape-controlled nanomaterials. Despite progress, more robust synthesis and validation procedures that use current and future trends that can boost AI-based applications are still lacking. It is anticipated that the intersection of AI and nanotechnology can shape the path for many technological developments using nanomaterials. The chapter outlines an overview of recent progress and potential pathways for new developments that highlight the synergism of AI and innovations for developing novel nanomaterials. Various tools and topics are introduced, viz. (a): big data in Materials Science –: analysis of structure-property relationships makes use of large datasets derived from experimental research, knowledge-based AI tools to predict characteristics for materials synthesis procedures, (b): future Implications–nanoscale characterization to gain extra value through the advancement of quantum computing together with advanced ML algorithm capabilities, and (c): interdisciplinary collaboration between AI researchers and material scientists to refine applications in electronics, optics, catalysis, medicine, agriculture, and sustainability.

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PL-2.1 Giant Hybrid Polymer/Lipid Vesicles: Phase Separation and Dynamics from Advanced Fluorescence and Microscopy Methodologies

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By mixing up lipids and polymers, a new entity, the “hybrid polymer/lipid vesicle” is created, and the aim is to reach an optimization of the characteristics of both partners in a single entity, combining the biocompatibility of lipids (as observed in liposomes) with the mechanical properties of pure polymer vesicles, the “polymersomes” (Figure 1).

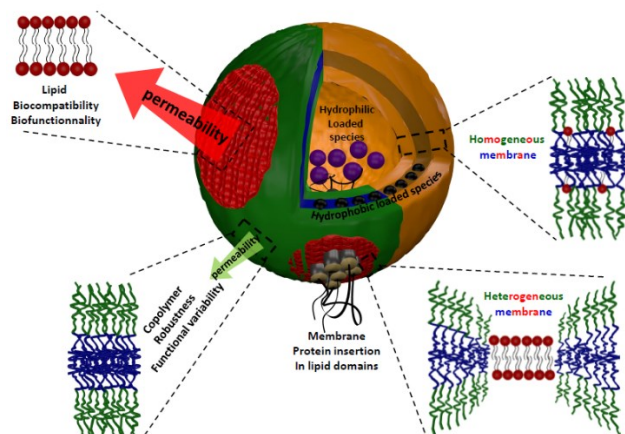


Fig. 1. Representation of a “polymersome” describing the various phases, and their properties [1].

This work focuses on the biophysical characterization of these vesicles. A detailed study of phase separation (lipid and polymer domains) was carried out by imaging Giant Hybrid Vesicles, using polymer and lipid fluorescent probes. Several types of polymers with different hydrophobic thicknesses were studied, which allowed for a rationalization of their influence on vesicle morphology (e.g., budding alterations vs. increasing of line tension), and different types of polymer architecture were considered (triblock vs. grafted). For the situation where no macroscopic phase separation is observed, the so-called “homogeneous distribution” under the confocal microscope, the detection of nano-domains was carried out by FRET-FLIM (donor in the polymer and acceptor in the lipid) [2].

The same nanodomains were also detected in Large Unilamellar Hybrid vesicles (HLUVs). - In this case, quantitative approaches for FRET in two dimensions were used in order to compare experimental results with the theoretical expectations for both “homogeneous distribution” and “infinite phase separation” [3].

The lateral diffusion within Giant Hybrid Vesicles was determined by FRAP, and it was concluded that the presence of lipid domains hinders polymer diffusion, at variance with the diffusion of lipid which is not slowed down [4].

Acknowledgements: FCT (Portugal)- Projects UIDB/04565/2020 and UIDP/04565/2020 (iBB) and LA/P/0140/2020 (i4HB). The authors also acknowledge funding from the Portuguese Platform of Bioimaging (PPBI-POCI-01-0145-FEDER-022122). LCPO - Laboratoire de Chimie des Polymères Organiques (Bordeaux, France) was the supplier of the materials in the framework of a IDS-FunMat (EU) program.

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PL-2.2 Nature's Solar Cells – Applying Nature to Technology

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Converting the sun's radiation into useful energy to support living systems is an area of intense study in photophysics, photochemistry and photobiology. Understanding energy capture in biology is therefore challenging to many areas of science, even today. But if we can learn from how nature captures the sun's energy with such high efficiency, it could benefit renewable energy capture. The potential for image detection and memory storage has also been suggested. Here, we will describe molecular investigations that have led to the design of bioinspired detectors, and explain some limitations of the approach.

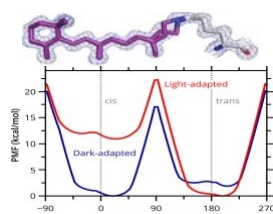


Fig. 1. Retinal in the dark- adapted state is modeling as in a 70:30 equilibrium confirmed by potential mean force calculations

Photoreceptors are one of the most abundant class of proteins in living systems and enable organisms to sense light and transduce this signal into a biochemical output. They are responsible for converting light into vital functions that include energy production and electrical signals leading to visual response. These photoreceptors, which are found in many life forms, from *Acheabacteria* to humans, are called rhodopsins and are the membrane-embedded proteins that are activated by light. With a common structural motif of 7-transmembrane helices (Fig 1), a single retinal molecule (vitamin A derivative) is embedded in the receptor which has an absorption spectrum determined by the polarity of its environment and isomeric form of the unsaturated chain (Fig. 2). Photoinduced isomerization of the retinal chain within the receptor determines action – retinal is a nanoswitch here.

Crucially, therefore, the conformation of retinal within the photoreceptor is vital to understanding action. The first structures for photoreceptors² were at a resolution ($\sim 7\text{\AA}$) where the retinal could not be defined (residual electron density was too diffuse). So, we addressed this challenge and resolved retinal conformation using (solid state) magnetic resonance approaches, initially designed to resolve drug and ligand structures in membrane bound targets³, and then adapted for retinals synthesized and incorporated into functionally competent membrane embedded rhodopsins to sub- $\text{\AA}$ resolution. The two photoreceptors for which we obtained this information were the proton pump bacteriorhodopsin (from the extreme halophilic Archaea, *Halobacterium halobium*)⁴ and the visual photoreceptor bovine rhodopsin in retinal membranes⁵, as examples of photoreceptors from two very different life forms and different actions, despite the same chromophore in structurally very similar protein environments.

More recently, we have complemented this structural work by developing novel methods to obtain very high resolution ($1.07\text{\AA}$)⁶ crystallographic data for an Archaeal photoreceptor used extensively in optogenetics, Archaerhodopsin 3 (a member of a family of 4 Archaerhodopsins, AR1, AR2, AR3 and AR4) for which no structure was available. Importantly, the photoreceptor is studied in a membrane environment and potentially denaturing detergents are not required^{7,8}. Now, at this resolution, the conformation of retinal can be readily resolved showing surprisingly that the retinal is in an equilibrium between the cis- and trans-isomer in the dark, with QM(SCC-DFTB)/MM MD trajectories showing how the relatively low energy barrier form interconversion is much lower in

the dark adapted form – there are not so many comparable structures of photoreceptors in the dark adapted form, and certainly not at very high resolution.

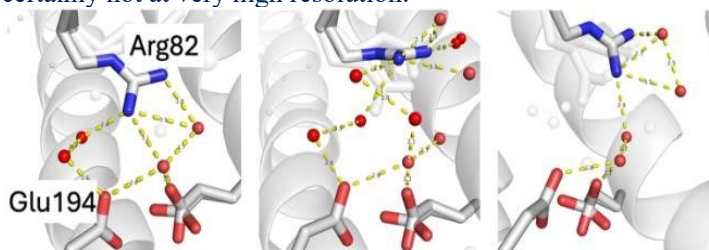


Fig 2: Rotamers of Arg82 support multiple H-bonding networks towards Glu194 and Glu204, and thus of many more pathways for translocation. Sensitization primarily affects the H-bonding network in the centre of AR3.

The receptor is also fully functional as a proton pump in controlled assays⁹ and is ~10x more efficient than bacteriorhodopsin at proton pumping under identical conditions. The protein retains some of the natural lipids in the crystals from mass spectrometry¹⁰. Mutational (1,2 or 3 residues) approaches, directed by the high-resolution information about the retinal binding site, permitted both hypsochromic and bathochromic functional versions of the receptor to be produced, giving the potential for different colour markers, and in optogenetics to facilitate multicomplex voltage imaging.

The new high-resolution information reveals that the waters in the proton release channel, involving Arg82 and Glu194, are more disordered in AR3 than bacteriorhodopsin, providing multiple pathways for proton translocation. Additionally, the AR family have an Ω -loop on the extracellular side of the membrane, providing a ready reservoir of waters for translocation. One, or both of these observations explain, at least partly, the higher efficiency of AR3 over bacteriorhodopsin. Also, photo-induced x-ray, free electron laser studies (XFELS; unpublished) show how water reorganization within the proton release pathway at the very earliest stages (1.5fs) of photon incidence.

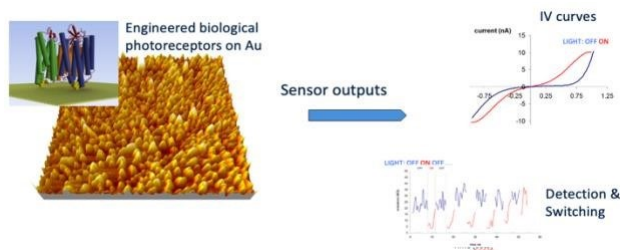


Fig. 3. Bacteriorhodopsin, covalently tagged to a $\sim 2\mu\text{m} \times 2\mu\text{m}$ Au chip through an engineering Cys-residue, as viewed by AFM – single molecules are 3 nm in diameter. Using contact AFM, repeated light induced IV responses are observed 11, 12.

The implications for technology driven and bio-inspired devices is now clearer. Biology works at a single molecule level, is noise free, works at low powers and very fast timescales. With potential for image detection, holography, photovoltaic devices and data storage, there are clear limitations for energy capture at the levels required for human use. A rudimentary image capture device has been developed by us (Fig 3), and others are now progressing the field. Also, implanting bacteriorhodopsin embedded into a suitable matrix, the first protein-based artificial retina has been developed to restore meaningful vision for patients who are blind or have lost significant sight (Fig 4).



Fig. 4. Representation of how a retinal utilizing the bacteriorhodopsin to restore functional sight (<https://www.lambdavisision.com>)

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PL-2.3 Bionic Limbs and Postamputation Pain

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Limb amputations drastically affect an individual's quality of life, making advanced prosthetic technologies essential to prevent life-long disability. While robotics have progressed significantly, achieving seamless, intuitive control and natural sensory feedback with artificial limbs remains a major challenge. Both intuitive motor control and sensory feedback are vital for functional prostheses. Techniques such as Targeted Muscle Reinnervation (TMR) [1] and Targeted Sensory Reinnervation (TSR) [2] have shown the benefits of reinnervating muscles and skin to replicate natural limb functions. Newer approaches, including Regenerative Peripheral Nerve Interfaces (RPNIs), Vascularized Denervated Muscle Targets (VDMTs), and Cutaneous Mechanoneural Interfaces (CMIs), hold potential but face hurdles in clinical adoption due to their dependence on implanted electrodes [3]. A variety of implantable systems have been researched but are not yet clinically available [4]. Osseointegration for skeletal attachment has proven to be an effective means of anchoring a prosthetic limb to the body [5], and more recently, this technology has been employed to solve the bidirectional communication challenge between implanted electrodes and prosthesis [6].

Using direct skeletal attachment via osseointegration, neuromuscular interfaces, and machine learning, we achieved the first clinical implementation of an artificial arm integrated directly into the patient's bone, nerves, and muscles [7]. In addition to direct skeletal attachment, this technology provides the unique opportunity to chronically record and stimulate the neuromuscular system in freely behaving humans, thus permitting investigate complex limb motions and somatosensory perception. The first patient implanted with this neuromusculoskeletal interface has used it without interruption for over 10 years in everyday life. Patients implanted with this system are also provided with intuitive sensory feedback via direct nerve stimulation [6]. Direct skeletal attachment via osseointegration, along with control and sensory feedback via implanted neuromuscular electrodes, can now be provided in a self-contained prosthesis for use in daily life without supervision outside controlled environments. Originally developed for above-elbow amputations, this technology has also been implemented in below-elbow amputations [8], and more recently, used with refined surgical reconstruction presenting the first concurrent implementation of TMR and RPNIs [9].

In addition to the functional challenges that limb loss represents, these patients often develop chronic neuropathic pain that further hinders their quality of life. Research and clinical innovations on the treatment of post-amputation pain have increased in the past decade. A growing interest on post-amputation pain, particularly in phantom limb pain (PLP), has resulted in new treatments, basic research findings, and theories that have increased our understanding of this condition [10]. In this lecture, I will provide an overview of the field and discuss his recent hypothesis for the neurogenesis of PLP, along with a novel theoretical framework for further understanding the condition and improving its treatment [11]. I will also discuss how motor decoding technology in combination with virtual reality has been used to treat PLP [12]. He will also describe how such technologies have been used for the functional and pain rehabilitation of sever sensorimotor impairments.

The Russian full-scale invasion of Ukraine has left over 100,000 people with amputations and a high incidence of PLP. I will also present the challenges of rehabilitation in the time of war after one year's experience of full-time humanitarian work.

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PL-2.4 Aero-materials and frameworks from Tetrapodal Zinc Oxide: A Versatile Platform for Biomedical, Sensing, and Energy Research to marked

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Tetrapodal zinc oxide (t-ZnO) microcrystals produced via flame transport synthesis [1] provide a versatile 3D template for creating ultralight “aeromaterials” with >99.9% porosity [2]. Since the first introduction of such aeromaterials in 2012 – notably *Aerographite*, considered those days as the world’s lightest material at 0.2 mg / cm^3 – these interconnected tetrapodal networks have enabled by their extreme porosity, high surface area, and tunable composition various interdisciplinary applications [3] that bridge the needs of biomedical engineering, environmental sensing, and energy technology.

In the biomedical realm, we have contributed to developed **smart wound scaffolds** that leverage t-ZnO’s functional properties for improved healing. For example, a 3D-printed hydrogel wound patch was engineered with embedded vascular endothelial growth factor (VEGF) and photoactive, antibacterial t-ZnO tetrapods [4 adv. Funct. harv]. Upon wireless UV/visible light exposure, the ZnO micro-networks act as local nano-generators to trigger on demand release of growth factors, while simultaneously providing inherent antibacterial action. Chemical surface modification of the tetrapods enhanced protein (VEGF) adhesion and allowed the composite hydrogel’s stiffness and degradation to be tuned to match healing dynamics. The resulting “smart” patch showed low cytotoxicity and significantly improved angiogenesis *in vitro*, and *in vivo* tests demonstrated reduced inflammation along with accelerated wound closure.

Beyond drug delivery, t-ZnO networks serve as building blocks for **soft electronics and sensors** integral to wearable and implantable devices. Recent creation of all-organic aero-conductors based on PEDOT:PSS polymer aerogels, created by coating ZnO tetrapodal frameworks with nanometer-thin conductive polymer films and then removing the sacrificial ZnO cores.[5] The resulting foam-like PEDOT:PSS/PTFE network is ultra-lightweight ($\sim 15 \text{ mg / cm}^3$) and exhibits a DC conductivity up to 184 S/m , which remarkably remains strain-invariant even under 80% compression or 25% tension. Moreover, a hydrophobic PTFE thin-layer imparts high stability in aqueous environments. These properties make them ideal for wearable health monitors or bioelectronic implants that demand reliable conductivity during motion and long-term use.

Leveraging the same aeromaterial paradigm, we have explored **stimuli-responsive actuators** by integrating conductive hollow networks into soft matter. Aerographene – a graphene-based aeromaterial derived from t-ZnO templates – exemplifies how an ultralight network can enable powerful actuation. Its finely-structured network of microtubular carbon (over 99% air) can be heated electrically at rates of several hundred $^{\circ}\text{C}$ per millisecond [6]. This rapid Joule heating of the air in the hollow tubes produces instantaneous gas expansion and contractions, essentially creating controllable “micro-explosions.” We demonstrated that by repeatedly and rapidly heating/cooling aerographene, one can drive extremely forceful pneumatic motions, enabling miniature yet powerful pumps and even sterilizing filters powered by electrical pulses.

Complementarily, in hydrogel-based soft robots, we showed that embedding a sparse ($\sim 5\% \text{ v/v}$) **microtubular graphene network** dramatically amplifies actuation performance. In a thermoresponsive poly(N-isopropylacrylamide) hydrogel, the bioinspired graphene network provides rapid, internal water transport pathways and photothermal heating capacity. This led to a ~ 4 -fold increase in actuation speed and a ~ 40 -fold increase in generated stress, overcoming the usual water diffusion limitations of hydrogels [7]. Notably, the conductive network also enables untethered actuation: the hybrid hydrogel can be triggered by light or electric fields without any wired connections, as the graphene network converts optical or electrical stimuli into heat internally. Such capabilities pave the way for **soft actuators** that operate efficiently in delicate environments (e.g. inside the human body or in soft robotics).

Furthermore, it will be illustrated how both tetrapodal zinc oxide and aeromaterials are being translated into **market-ready products**, including through commercialization efforts by start-up companies.

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PL-2.5 TlBr Thin Film Radiation Detector for X-ray Imaging Device

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This study presents the development and evaluation of a high-resolution X-ray imager utilizing thallium bromide (TlBr) thin film detectors, highlighting their strong potential for next-generation X-ray imaging devices. TlBr is a compound semiconductor with favorable physical characteristics, such as high atomic numbers (Tl: 81, Br: 35), high density (7.56 g/cm³), and a wide bandgap of 2.68 eV. These properties enable room-temperature operation, strong X-ray attenuation, and direct conversion of incident photons into electrical signals without the use of scintillators [1], [2]. However, despite these advantages, the integration of TlBr into flat-panel detector (FPD) systems has been limited by challenges such as polarization phenomena, electrode degradation, and fabrication complexity [3], [4].

In this work, we demonstrate a prototype TlBr-based X-ray imager constructed using a combination of existing technologies. The detector comprises a mechanically polished TlBr crystal (3.2 mm × 3.2 mm × 0.8 mm), equipped with an asymmetric electrode structure: a plate electrode incorporating thallium metal to suppress polarization during hole collection, and pixelated silver electrodes with an 80 μm pitch on the opposing side. The electrodes are connected to a photon-counting readout integrated circuit (ROIC) via a silver paste bump-bonding process. The ROIC, designed in-house and fabricated using a TSMC 0.13 μm CMOS process, supports charge-sensitive amplification and digital output via pulse-width modulation, allowing both electron and hole collection modes [5].

Experimental imaging was performed using an X-ray tube operating at 90 kV. In the absence of irradiation, the detector exhibited minimal leakage current, and initial images revealed a number of hot pixels attributed to surface roughness and nonuniform pressure during stacking. By refining the polishing process and improving wafer flatness, the hot pixels were substantially reduced, enabling uniform signal acquisition across the detector area. X-ray images of test objects, including a Japanese lead character and a multi-line-pair X-ray test chart, were acquired. Pixel value normalization was conducted using flat-field correction based on reference "white images".

Analysis of spatial resolution was carried out by measuring the modulation transfer function (MTF) from the test chart data. The imager clearly resolved line pairs up to 5 lp/mm, with particularly strong performance at 2–3 lp/mm, near the Nyquist frequency of 3.125 lp/mm for the given pixel pitch. The calculated MTF closely matched the theoretical sinc function corresponding to 180 μm sampling, despite the imager not being specifically optimized for TlBr signal processing. The MTF value at 2 lp/mm exceeded 80%, surpassing typical indirect detectors and rivaling state-of-the-art direct conversion detectors based on CdTe.

Beyond spatial resolution, the study also investigated long-term operational stability, particularly the manifestation and recovery of the polarization phenomenon—a known issue in TlBr detectors due to the mobility of Br[−] ions under bias. Under prolonged X-ray exposure in the electron collection mode, image contrast gradually degraded, attributed to ion accumulation and electrode reaction. However, switching to the hole collection mode (via reverse bias) resulted in a gradual recovery of image quality over 60 minutes, indicating successful ion redistribution and polarization mitigation [4], [5]. Continued operation in the hole collection mode maintained image contrast, confirming the stabilizing effect of the thallium-containing electrode.

Further experiments involved switching back to the electron collection mode, which partially restored image contrast. However, some irreversible degradation remained, possibly due to the formation of silver bromide (AgBr) at the electrode interface, a reaction previously observed in other metallic electrodes [6]. These findings indicate that while bias switching is effective for short-term recovery, full restoration may not be feasible once chemical reactions have occurred at the interface.

Overall, the study demonstrates the feasibility and advantages of integrating TlBr into high-resolution X-ray imaging systems. The successful combination of fine-pitch electrodes, thallium-based polarization suppression, and photon-counting ROIC architecture provides a promising path

toward the realization of TlBr-based flat-panel detectors. Despite the lack of dedicated optimization for TlBr in the current ROIC design, the system achieved performance metrics comparable to commercial direct detectors. The insights gained from this study—including the electrode structure, bias-switching methodology, and stacking process—lay the groundwork for future development of scalable, application-specific TlBr imaging devices for medical diagnostics, industrial non-destructive testing, and security applications.

In conclusion, TlBr thin-film detectors exhibit strong potential as X-ray photoconductors with high spatial resolution, operational stability, and material efficiency. The current work not only verifies the fundamental feasibility of such systems but also highlights critical design considerations for future FPD integration. This progress may serve as a catalyst for dedicated TlBr process development, enabling the broader adoption of these detectors in high-performance X-ray imaging platforms.

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PL-2.6 Teaching Medical Device Regulation, Management, and Assessment Using AI: An Exploratory Trial

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Aim - Introduction: Biomedical Engineering (BME) education in the areas of Medical Device (MD) Regulation, Health Technology Management (HTM), and Health Technology Assessment (HTA) is becoming increasingly complex due to rapidly evolving regulatory frameworks, emerging technologies, and the growing need for holistic life cycle management of health technologies. This study explores an innovative educational model that leverages Artificial Intelligence (AI) to prepare BME students more effectively for navigating regulatory systems, optimizing device management, and applying evidence-based assessment to improve healthcare delivery.

Novelty: This work investigates the integration of AI-based tools and case-based learning to enhance student engagement and autonomy at the intersection of MD regulation, HTM, and HTA. Central to this approach is a self-learning model supported by AI and facilitated by an expert, marking a shift from traditional didactic methods to an interactive, adaptive, and student-centered learning paradigm.

Methods: A blended learning model was piloted within a BME Master's program. Following a brief introductory lecture, students engaged in self-directed learning using generative AI tools, with the instructor transitioning into the role of a facilitator. The course was divided into three main topics: Regulation, Management, and HTA of Medical Equipment. Students were assigned in six groups of two and tasked with studying one of the three topics in depth, using AI to research and prepare structured lecture notes. These notes were designed to serve as learning material for peers assigned to other topics. Weekly supervision meetings were held to monitor progress, during which each group presented their evolving work and received formative feedback. Over 3–4 iterations, the materials were refined and, upon final review by the facilitator, approved for distribution to the rest of the class. This peer-teaching strategy aimed to foster collaborative learning, content ownership, and cross-topic integration, while allowing students to explore MD regulation, HTM, and HTA through AI-enhanced educational support.

Results: The six final sets of lecture notes were of high quality, requiring only minor revisions. While final exam results are pending at the time of this abstract's submission, early indicators suggest the approach has been highly effective. Students responded positively to the AI-assisted methodology, reporting increased engagement, critical thinking, and improved understanding of complex regulatory, managerial, and assessment concepts. Informal feedback highlights their improved ability to navigate regulatory pathways, strategize device management, and comprehend HTA frameworks. A comparative analysis of student performance—between those who developed their topic independently and those who learned from peers' materials—will be conducted following the course's conclusion to validate the pedagogical impact.

Conclusion: To meet the evolving demands of the medical device sector, BME education must adopt modern, student-centered methodologies. This study demonstrates that AI-enhanced, facilitator-guided learning models can significantly enrich educational outcomes, foster interdisciplinary skills, and better prepare future professionals to address the complex regulatory, technical, and evaluative challenges of the contemporary healthcare landscape.

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PL-3.2 Personalized Medicine in Cancer Care: How Genomic Profiling and Liquid Biopsy Are Shaping the Future of Targeted Cancer Therapies

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In recent years, cancer treatment has witnessed a major evolution with the rise of personalized medicine. This approach aims to tailor treatment strategies based on the unique molecular and genetic characteristics of both the tumor and the patient. Rather than relying solely on tumor location and histology, modern oncology now incorporates detailed genomic and molecular profiling to drive clinical decision-making. Two of the most transformative tools in this paradigm are genomic analysis and liquid biopsy, which have redefined how we diagnose, treat, and monitor malignancies.

The Impact of Targeted Therapies in Oncology

Targeted therapies have fundamentally changed the landscape of cancer care. Unlike conventional chemotherapies, which indiscriminately damage rapidly dividing cells, targeted agents are designed to interfere with specific molecular pathways or mutations that drive tumor growth and survival. This allows for more effective tumor control with fewer systemic side effects.

Examples of successful targeted therapies include EGFR inhibitors in non-small cell lung cancer, HER2-targeted agents in breast and gastric cancers, ALK and ROS1 inhibitors in lung cancer, BRAF inhibitors in melanoma and colorectal cancer, and PARP inhibitors in BRCA-mutated ovarian and breast cancers. These therapies have significantly improved progression-free and overall survival, often turning previously lethal malignancies into manageable chronic conditions. Moreover, the ability to identify resistance mechanisms has allowed clinicians to switch or combine therapies at the right time, increasing long-term disease control.

The integration of these therapies into clinical practice depends on accurate and timely molecular diagnosis, which is where genomic analysis and liquid biopsy come into play.

Genomic Analysis: Guiding Precision Treatment

Next-generation sequencing (NGS) has become the backbone of personalized oncology. By sequencing multiple genes simultaneously from a tumor biopsy, NGS detects genetic alterations such as point mutations, insertions, deletions, copy number variations, and gene fusions. This allows oncologists to identify "actionable" mutations—those for which effective targeted drugs are available or in development.

For example, the presence of PIK3CA mutations in breast cancer or NTRK fusions in various solid tumors can now be matched with specific inhibitors. Genomic testing is not limited to therapy selection; it also plays a role in prognosis, eligibility for clinical trials, and prediction of treatment resistance.

Clinical guidelines now recommend broad genomic profiling in many advanced-stage cancers, especially when standard treatment options are limited. However, challenges remain, including sample sufficiency, tumor heterogeneity, and turnaround times. This is where liquid biopsy serves as a valuable adjunct.

Liquid Biopsy: A Non-Invasive Window into Tumor Biology

Liquid biopsy refers to the analysis of tumor-derived material—most commonly circulating tumor DNA (ctDNA)—in peripheral blood. It offers several advantages over traditional tissue biopsy: it is less invasive, can be repeated over time, and provides a more comprehensive view of tumor heterogeneity and evolution.

The main applications of liquid biopsy include:

- **Detection of actionable mutations** when tissue is unavailable or insufficient,
- **Monitoring treatment response** and identifying minimal residual disease (MRD),
- **Early detection of resistance mutations**, allowing timely therapy adjustment,
- **Surveillance in high-risk patients** for recurrence or progression.

Technically, liquid biopsy involves blood collection, plasma separation, ctDNA extraction, and ultra-sensitive sequencing or PCR-based detection of specific mutations. Recent technological advancements have enhanced sensitivity and specificity, enabling detection of even low-abundance mutations with clinical relevance.

In certain cancers, such as lung, colorectal, and breast cancers, liquid biopsy is becoming standard practice for mutation detection and disease monitoring. In some instances, it has even replaced tissue biopsy as the first-line diagnostic approach, especially when rapid information is needed.

In clinical oncology, integrating genomic and liquid biopsy results into treatment planning requires a multidisciplinary approach. Molecular tumor boards, consisting of oncologists, pathologists, geneticists, and bioinformaticians, are increasingly common in comprehensive cancer centers to ensure appropriate interpretation and application of test results.

Future Perspectives and Remaining Challenges

Despite the remarkable progress, several challenges hinder the widespread adoption of personalized oncology:

- **Cost and reimbursement** remain barriers, particularly in low-resource settings.
- **Test availability and standardization** vary across regions.
- **Interpretation of variants of unknown significance (VUS)** complicates clinical decisions.
- **Ethical considerations**, including data privacy and incidental findings, require careful navigation.

Nonetheless, as the costs of sequencing continue to decline and artificial intelligence enhances interpretation, personalized cancer care will become more accessible and impactful.

Looking ahead, combining genomic analysis with other “omics” technologies—such as transcriptomics, proteomics, and metabolomics—will further refine our understanding of cancer biology. Moreover, real-time monitoring via liquid biopsy opens new possibilities for adaptive treatment strategies, where therapy evolves alongside the tumor’s molecular changes.

Conclusion

Personalized medicine is no longer a future concept—it is now an essential component of modern cancer care. Through genomic analysis and liquid biopsy, oncologists are empowered to deliver more precise, effective, and humane treatment. These technologies not only improve outcomes but also offer patients a message of hope—transforming cancer from a terminal illness to a manageable condition for many. As we continue to innovate and integrate these tools, the dream of truly personalized care is becoming a clinical reality.

PL-3.3 New Topological Transitions in Superconductor Nanoarchitectures

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Advanced high-tech fabrication techniques made it possible to fabricate geometrically complex and topologically nontrivial 3D nanoarchitectures, which reveal novel electronic, magnetic, optical and transport properties [1–3]. In 3D superconductor nanoarchitectures, a topological transition between the vortex and phase-slip regimes determines the magnetic-field–voltage and current–voltage characteristics revealing a nontrivial topology of SC screening currents.

Recently, microwave generation by vortex jets in open superconductor nanotubes [4] has been explored. It is found that vortex chains, vortex jets, and phase-slip regimes occur in superconductor open nanotubes due to the inhomogeneity of the normal magnetic field component. At lower magnetic fields, vortices follow the same path within the half-tubes, forming single vortex chains. At higher magnetic fields, the vortex trajectories undergo multifurcations, giving rise to patterns composed of vortex jets consisting of two or more vortex chains. Due to a stronger confinement of single vortex chains in tubes of small radii, jumps in the average voltage and frequency of microwave generation are unveiled, which occur when the number of fluxons moving in the half-tubes increases by one. 4-point electrical transport measurements in the superconductor W-C nanobridge allows one to study the motion of superconducting vortices in 3D [5].

Based on a finite-element implementation of the TDGL theory, the confinement is shown to lead to a bending of the vortices within the bulk. The experimentally observed strong geometrical anisotropy of the critical magnetic field is a manifestation of the reconfigurable coexistence of superconducting and normal states in the 3D nanoarchitecture along with the local definition of weak links. This regime of superconductivity at the nanometer scale, where the vortex state is truly 3D and can be efficiently tailored by geometrical confinement, offers a route to local reconfigurable control of superconductor 3D nanoarchitectures.

In superconductor open nanotubes and nanopetals, carrying an azimuthal transport current in a homogeneous external magnetic field, the complex geometry induces an inhomogeneity of the magnetic field and makes the vortices to move along preferred paths [1]. By introducing a lattice of anisotropic pinning sites along these paths, a non-reciprocal flux transport is realized. A vortex ratchet effect is revealed to be strongly tunable by the degree of anisotropy and can be made stronger than that in the respective planar membranes. The enhancement of the vortex ratchet effect becomes apparent via a difference in the depinning current under the current reversal, and it is attributed, under appropriate conditions, to the inhomogeneous-field-induced vortex channeling through the areas containing the asymmetric pinning sites [6]. These results imply that the ratchet effect can persist up to higher magnetic fields via extending a superconducting film into the third dimension, without an increase in the number of asymmetric pinning sites. These predictions can be examined on self-rolled superconducting 3D nanoarchitectures with artificial pinning sites created using focused ion and electron beams.

I gratefully thank I. A. Bogush, R. Córdoba, R. H. de Bragança, O. V. Dobrovolskiy, C. Donnelly, and E. Zhakina for fruitful collaborations. The study was supported by the E-COST Action #CA21144 “Superconducting Nanodevices and Quantum Materials for Coherent Manipulation”.

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PL-4.1 Superconducting Artificial Neural Networks: Spintronic Innovations for Neuromorphic Computing

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The rapid evolution of modern computing systems has brought about an exponential increase in energy consumption, primarily driven by the classical von Neumann architecture introduced by John von Neumann [1]. This architecture, while foundational to today's digital computers, faces critical limitations in terms of power efficiency and scalability, especially as demands for high-performance computing, artificial intelligence, and big data analytics continue to rise [2]. Consequently, the scientific community has emphasized the urgent need for alternative computing paradigms that can significantly reduce energy consumption without compromising processing capabilities.

In this context, neuromorphic computing—an approach inspired by the structure and function of biological neural networks—has emerged as a promising avenue. Artificial Neural Networks (ANNs), which mimic the complex interconnectivity of neurons and synapses in the brain, offer a pathway towards highly efficient, scalable, and adaptive computational systems [3-4]. While traditional implementations of ANNs rely on semiconductor-based components, recent advances suggest that integrating superconducting elements can drastically lower energy dissipation, thanks to the zero-resistance properties of superconductors. This makes superconducting Artificial Neural Networks (SANNs) a compelling candidate for next-generation neuromorphic hardware, capable of overcoming the limitations inherent in CMOS technology [5-7].

This research focuses on the development of superconducting artificial neurons founded on superconducting spin valves, as well as artificial synapses constructed from innovative hybrid nanostructures. The core idea is to exploit the unique properties of superconducting/ferromagnet layered nanostructures—specifically superconductor/ferromagnet (S/F) heterostructures—to realize energy-efficient, flexible, and tunable components for neuromorphic systems. The study involves detailed analysis of the proximity effect within multilayer S/F nanostructures, where ferromagnetic cobalt (Co) layers of varying thicknesses and coercive fields are integrated with superconducting niobium (Nb) layers. The Nb layers are chosen to have a thickness corresponding to the superconducting coherence length, optimizing the interplay between superconductivity and ferromagnetism [8-14].

The investigation aims to understand how these layered nanostructures behave under different magnetic and thermal conditions, with particular emphasis on the modulation of superconducting states by ferromagnetic layers—an essential aspect for designing functional artificial neurons and synapses. Experimental studies include fabrication of the hybrid nanostructures, low-temperature measurements, X-ray diffraction (XRD) characterization, and rigorous modeling of their electrical and magnetic properties. The ultimate goal is to harness the proximity-induced effects to create superconducting spintronic elements that can emulate neural activity with minimal energy expenditure.

In the context of neuromorphic computing, these superconductor/ferromagnet hybrid structures hold great promise for developing scalable, high-speed, and energy-efficient artificial neurons and synapses. Such devices could not only reduce power consumption but also enable faster information processing, contributing significantly to the advancement of quantum and classical hybrid computing platforms. The results of this research depict a compelling pathway toward the integration of superconducting spintronics into neuromorphic architectures, with potential implications for future artificial intelligence systems.

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PL-4.2 Advanced Hybrid Nanomaterials for Biomedical and Environmental Sensor Technology

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Hybrid nanomaterials are critical in advancing healthcare diagnostics, which can be used for real-time monitoring and selective detection of chemical and biological analytes. Among them, the most important application is breath analyser for the detection of biomarkers such as acetone for diabetes diagnosis, ammonia for renal failure [1], 2-propanol for lung cancer [2, 3] or hydrogen for lactose intolerance and other diseases of digestive system [4]. However, it is challenging to selectively detect biological analytes at elevated temperatures. This plenary talk covers the potential of advanced hybrid nanomaterials in overcoming these limitations, for the enhanced sensitivity of acetone and hydrogen.

ZIF-coated metal oxide-based hybrid materials have been explored from last two decades. Its employment in sensing field is emerging with some prominent works. For instance, Poschmann et al. studied the pin-hole free surface conversion of tetrapodal ZnO into ZIF-8 for the selective detection of hydrogen which can be attributed to the molecular sieving effect [5]. Similarly, another study based on core-shell structure of ZIF-8 coated ZnO employed for dual applications, i.e., hydrogen sensing and UV-sensing. ZnO microparticles were 3D-printed on a substrate then its surface conversion to ZIF-8 shows notable sensing to 100 ppm of hydrogen at 250°C [6]. Moreover, ZIF-based hybrid nanostructures on dual phase *p*-type CuO/Cu₂O nanostructures also exhibited dual sensing capabilities by showing room temperature-based UV detection and hydrogen and VOC sensing at elevated temperatures [7]. Furthermore, a study on 3D-printed Al₂O₃/ZnO heterostructures demonstrated significant UV detection and temperature sensing as dual functionalities [8].

In the recently work, Al₂O₃/CuO films were synthesized using a cost-effective and simple chemical solution approach (SCS). Followed by the photothermal annealing at 500°C for 60 s. Subsequently, a 12 nm Al₂O₃ overlayer was developed on CuO/Cu₂O layer and then again thermally annealed at 610°C for 1 h. Furthermore, vapor-solution based ZIF-8 preparation and its drop-casting on CuO nanostructures exhibit highly selective sensing of hydrogen at 225°C and acetone sensing at 300°C. The selective detection of acetone and hydrogen at their respective operating temperatures can be explained on the basis of electrostatic potential structure.

Similarly, the selectivity could be explained through different coatings, be it ZIF or polymers, which acts like sieves, as various analyte vapours having different diameters of molecules only a certain group could be detected. This study is important for biomedical and environmental sensor technology as it adds new methods of tuning gas sensors properties. This work was partially supported by LIFETECH, 020404 at TUM.

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PL-4.3 Artificial Intelligence for Evidence-Based Management of Medical Devices

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The increasing integration of Health Information Technologies (HITs) into healthcare systems has amplified the need for robust methods to classify failures accurately, with the dual goal of enhancing maintenance strategies and reducing adverse events. Addressing this demand, our study investigates a self-supervised machine learning framework designed to standardize failure classification in HITs using real-world data (RWD).

HITs encompass a broad range of digital solutions, from Electronic Health Records (EHRs) to Picture Archiving and Communication Systems (PACSs) and are pivotal to the modernization of healthcare delivery. Despite their widespread adoption and the significant investments involved, maintaining these systems' reliability remains a challenge. An emerging approach is evidence-based maintenance (EBM), which leverages RWD to inform and optimize maintenance decisions. [1, 2]

However, the effectiveness of EBM is hindered by the lack of standardized failure classifications, particularly for HITs. [3] Existing spontaneous reporting systems (SRs), such as the U.S. Manufacturer and User Facility Device Experience (MAUDE) database, contain vast amounts of unstructured textual data on adverse events. Manual analysis of these data is impractical, underscoring the need for automated, scalable solutions.

Building on our prior work in applying Natural Language Processing (NLP) to classify medical device failures, this study extends the methodology using a self-supervised learning approach. [4] We specifically target HIT-related adverse event reports from the MAUDE database, selecting records from 2022 to 2024. After preprocessing, which included filtering out irrelevant or corrupted data and ensuring uniqueness among textual entries, we curated a dataset of approximately 19,000 records pertinent to HIT failures.

Self-supervised learning presents a compelling choice for this task as it does not require manually labeled data, which are often costly and time-consuming to produce. We employed various NLP models, notably different BERT (Bidirectional Encoder Representations from Transformers) architectures, to perform masked language modeling. A carefully engineered prompt—"The failure of this medical device is caused by a [MASK] error"—was appended to each report, guiding the model to predict suitable failure classes. The training was performed using freely available Google Colab T4 GPU resources. To refine the classification output, we limited the number of predicted classes per record to the top ten based on their probability scores, balancing granularity with interpretability. A weighted probability mechanism was then used to distill these into the final set of failure class candidates. An optimal cluster number of 200 was determined through distance metrics in clustering analysis, ensuring a balanced trade-off between intra-cluster similarity and inter-cluster separation. Among the models tested, the BERT_Base_Uncased model exhibited the best performance in classifying HIT failure records.

The analysis produced ten prominent failure: Design, Human, Technical, Software, Mechanical, System, Maintenance, Communication, Computer, and Manufacturing. These classes align well with known failure patterns in medical software systems. For instance, "Design" failures encompass issues in software architecture and user interfaces, while "Human" errors relate to misuse or operational mistakes by healthcare personnel. "Communication" errors typically involve network failures disrupting system connectivity. Although some classes like "System" and "Computer" are more generic, their emergence corroborates the contextual relevance of the model's outputs.

The results demonstrate that self-supervised learning, using masked language modeling, can effectively generate an initial taxonomy for classifying failures in Health Information Technologies. The identified categories—such as design flaws, human errors, and communication issues—are consistent with known failure modes in healthcare environments, suggesting the approach's validity. Although some classes are broad, their relevance highlights the potential of this method for supporting evidence-based maintenance practices [4]. Future refinements, including improved

dataset balancing and model optimization, could enhance classification accuracy. Overall, this preliminary framework offers a promising foundation for standardizing HIT failure reporting, facilitating benchmarking, and advancing clinical engineering toward more data-driven maintenance strategies.

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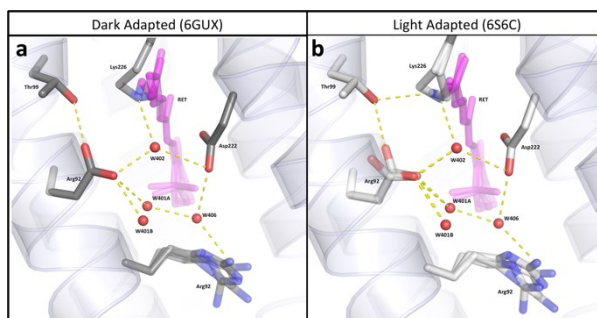
Importance of Water in Biology - an Example of Receptor Function and Implications for Optogenetics

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Water, in its many states, has a pivotal role in biology. But resolving it at the molecular level has been a challenge. Here, we resolve and describe how water determines the way in which an external stimulus, light in this example, intimately controls how the stimulus is conformational changes in membrane receptors in response to a stimulus, and capturing their functionally relevant dynamics, is very challenging. Over the years we have addressed this challenge using a range of spectroscopic approaches [1,2,3] on functionally competent photoreceptors, often in their natural membranes [4] or Lipidiscs™ [5,6]. More recently, we have complemented this work with functional



studies, mass spec characterization [7] and very high resolution (1.07Å) crystallography [8,9,10], as well as photo-induced x-ray, free electron laser studies (XFELS), without the use of detergents and including natural lipids. This high-resolution information reveals waters and their importance in both receptor activation-desensitization and QM(SCC-DFTB)/MM MD trajectories give information about the activation process. The system studied is achearhodopsin-3 (AR3), a photoreceptor utilized widely in optogenetics despite the lack of structures until now. We suggest that the different arrangement of internal water networks in AR3 is responsible for the faster photocycle kinetics compared to homologs – AR3 is ~10x more efficient than bacteriorhodopsin at current generation. These insights may well have generic implications for other receptors.

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Inverse Problems in Ultrasound Imaging: From Statistical Models to Deep Learning

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We present novel methods for computational imaging and image analysis in the context of two different applications of ultrasonography, involving on the one hand standard medical ultrasound of the lungs for chronic kidney disease monitoring and on the other hand the compressed sensing (CS) acquisition and reconstruction of quantitative acoustic microscopy (QAM) images.

First, we introduce a method for detecting straight lines (B-lines) in medical ultrasound images of the lungs for children with severe kidney conditions, undertaking diagnosis [1]. We addressed this as a sparse estimation problem using both convex and non-convex optimisation techniques based on the Radon transform and sparse regularisation. This breaks into subproblems which are solved using proximal splitting approaches. We include an additional deblurring step in the Radon domain via a total variation blind deconvolution to enhance line visualization and to improve line recognition. We evaluate our approach on a real clinical application: the identification of B-lines in lung ultrasound images. Thus, an automatic B-line identification method is described, using a simple local maxima technique in the Radon transform domain, associated with known clinical definitions of line artefacts. Using all initially detected lines as a starting point, our approach then differentiates between B-lines and other lines of no clinical significance, including Z-lines and A-lines. We evaluate our techniques using as ground truth lines identified visually by clinical experts. The proposed approach achieves the best B-line detection performance as measured by the F score when non-convex regularization is employed [2].

We subsequently describe a framework for compressive sensing data acquisition and reconstruction in QAM [3]. Three different CS patterns, adapted to the specifics of QAM systems, were investigated as an alternative to traditional raster-scanning approaches. They consist of diagonal sampling, a row random, and a spiral scanning pattern and can all significantly reduce both the acquisition time and the amount of sampled data. For subsequent image reconstruction, we design and implement an innovative technique, whereby an approximate message passing (AMP) framework is adapted to account for the underlying data statistics. A Cauchy maximum a posteriori image denoising algorithm is thus employed to account for the non-Gaussianity of QAM wavelet coefficients. The proposed methods were tested on experimental data acquired with a 250- or 500-MHz QAM system. The experimental data were obtained from a human lymph node sample (250 MHz) and human cornea (500 MHz). Reconstruction results showed that the best performance is obtained using a spiral sensing pattern combined with the Cauchy denoiser in the wavelet domain. The spiral sensing matrix reduced the number of spatial samples by a factor of 2 and led to an excellent peak signal-to-noise ratio of 43.21 dB when reconstructing QAM speed-of-sound images of a human lymph node. These results demonstrate that the CS approach significantly improves scanning time, while reducing costs of future QAM systems.

In the sequel, the frameworks presented for the two applications, which rely on standard optimisation theory for cost function minimizations are unrolled into deep learning architectures.

The issue of B-lines identification LUS images is thus addressed with a novel unsupervised deep unfolding network structure (DUCPS) [4]. The framework utilizes deep unfolding procedures to merge traditional model-based techniques with deep learning approaches. By unfolding the Cauchy proximal splitting CPS algorithm [2] into a deep network, DUCPS enables the parameters in the optimization algorithm to be learnable, thus enhancing generalization performance and facilitating rapid convergence. We conducted entirely unsupervised training using the Neighbor2Neighbor (N2N) and the Structural Similarity Index Measure (SSIM) losses. When combined with an improved line identification method, state-of-the-art performance is achieved, with the recall and F2 score reaching 0.70 and 0.64, respectively. Notably, DUCPS significantly improves computational efficiency, eliminating the need for extensive data labeling, representing a significant advancement over both traditional algorithms and existing deep learning approaches.

Finally, for the QAM CS image reconstruction problem, we investigate the use of AMP-Net, a deep unfolded model of AMP, for the CS reconstruction of QAM parametric maps [5]. Results indicate that AMP-Net can offer superior reconstruction performance even in its stock configuration trained on natural imagery (up to 63% in terms of PSNR), while avoiding the emergence of sampling pattern related artefacts.

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S-IFMBE/MBEC-1 How to Write and Publish a Scientific Paper?

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Preparing and submitting a manuscript for publication can be a challenging task, particularly for researchers in the early stages of their careers. Finding the best strategy and format to communicate one's research work in a manner that is comprehensible to others, and acceptable for publication, requires technical writing and communication skills that are often accumulated and polished throughout a scientist's career. Additionally, navigating the ever increasing pull of available publication platforms, from open research repositories to journals specialized on very narrow scientific fields, or journals covering a wide-range of topics is not an easy task.

In this talk, we will sequentially focus on all aspects involved in the preparation, writing and submission of a scientific manuscript. The discussion will be centered on the perspective of all actors involved in the process: the author's, the reviewers and the journal's editors perspective.

Essential aspects in the early stages of manuscript preparation will be initially presented, including the documenting, strategizing and organizing the author's work. Subsequently, a few tips will be given on how to identify the target journal coupled with a brief discussion on the various options for publication (e.g. open access, hybrid journals, preprint repositories) underlying their advantages and disadvantages.

The presentation will then elaborate on the main aspects of preparing the manuscript, such as advice on how to identify and highlight the novelty in author's work to ensure the message that the authors intend to relay to the readers about their work is clearly presented, in an efficient manner, thus maximizing the manuscript's impact. Subsequently, the need to optimally structure the manuscript, and ensure the writing flow will be discussed, with tips given on styling and visualization options, as well as advice on what to avoid and what to emphasize.

As the standards for scientific publications involve a voluntary peer review process, which is a critical step in getting someone's work published, important aspects will be elaborated on. These include aspects that reviewers typically focus on and the authors should be aware of, as well as strategies on how to respond to reviewers and editors requests in an appropriate fashion, ensuring a constructive communication during the review process. Additionally, the editor's perspective on common reasons for manuscripts rejection will be presented, with advice on how these can be avoided. The various review process formats, such as single-blind, double-blind and open review will be discussed as well.

Finally, we will outline a few aspects related to the resources available to authors for collaborative writing, editing and organizing their manuscripts that can assist during the manuscript preparation. This will also include a discussion on the use of the artificial intelligence tools in editing manuscripts.

SECTION S1

Nanotechnologies and Nanomaterials

S1-1.1 (842) Gigafactories: Powering the Future with Advanced Electrode Manufacturing (Invited)

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The global transition towards sustainable energy and electrified mobility hinges critically on the mass production of high-performance batteries, a demand being met by the rise of Gigafactories – colossal manufacturing ecosystems poised to define the future of energy storage. While these facilities represent monumental engineering achievements, their ultimate success and the ability to truly power our future are inextricably linked to the sophistication and efficiency of their core processes, paramount among which is advanced electrode manufacturing. This presentation delves into the cutting-edge techniques and innovations shaping electrode production at the Giga-scale, the very heart of every battery cell. We will first navigate the intricacies of advanced wet coating processes, the incumbent technology for high-volume electrode fabrication. This exploration will cover optimized slurry formulations designed for high-speed, defect-free coating, innovations in solvent recovery systems crucial for environmental compliance and cost reduction, and the engineering challenges of ultra-wide coating and rapid thermal drying necessary to achieve Gigafactory throughput. The discussion will emphasize how continuous improvements in precision control and material handling are pushing the boundaries of conventional wet processing to meet unprecedented production targets. The presentation will then illuminate the transformative shift towards dry electrode coating technologies, a paradigm poised to revolutionize battery manufacturing. We will meticulously examine various solvent-free methodologies, from powder mixing and direct material deposition to binder fibrilization and innovative compaction techniques. The profound advantages of dry processing – including significantly reduced energy consumption, a minimized factory footprint, elimination of toxic solvents, potential for enhanced electrochemical performance through novel electrode architectures, and a substantial decrease in manufacturing costs – will be detailed. Furthermore, we will address the ongoing research and engineering efforts aimed at overcoming the challenges of scaling dry processes to Gigafactory volumes while ensuring robust quality and consistency. By dissecting these advanced wet and dry electrode manufacturing pathways, this presentation will underscore how innovation in electrode science and engineering is fundamental to unlocking the full potential of Gigafactories. These advancements are not merely incremental; they are essential enablers for producing.

S1-1.2 (695) Analysis of Photoelectronic Processes in Silicon Structures with Opposing Potential Barriers

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Silicon structures incorporating contact points between depleted layers with opposing n–p and p–n potential barriers demonstrate unique photoelectronic properties arising from the interplay of their counteracting currents. When electromagnetic radiation with longitudinal absorption successively passes through the active regions of near-surface and back p–n junctions, it produces a compensated photocurrent exhibiting unconventional spectral characteristics that enable novel functionalities. This work extends previous research by examining how structural and technological parameters govern photoelectronic processes, specifically clarifying the conditions for spectral photocurrent sign reversal and the mechanisms of internal amplification through potential barrier interactions. The sign inversion results from asymmetric potential barriers, while current amplification occurs when barriers are balanced, with enhancement factors derived from experimental photocurrent values assuming 100% absorption efficiency. The amplification mechanism involves substantial electron injection from the forward-bias p–n junction into the p-base, facilitated by barrier height reduction from both applied voltage and space charge compensation by photogenerated carriers. The near-surface barrier's height advantage establishes a characteristic voltage range where progressive barrier equalization induces spectral photocurrent inversion. Mutual compensation of currents in oppositely directed potential barriers creates extremely low dark currents. These findings provide critical insights for developing tunable silicon photodetectors with injection spectral response and enhanced sensitivity.

S1-1.3 (698) Impact of Precursor Concentration on Topology, Wettability and Electrical Properties of Zn₂SnO₄ Films obtained by Spray-Pyrolysis

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In this study, Zn₂SnO₄ thin films were synthesized using the spray-pyrolysis technique with varying precursor concentrations (0.05 M, 0.15 M, 0.3 M) to investigate their influence on film topology, wettability, and electrical properties, aiming to explore their potential applications in photodetectors and microfluidics. The grown oxide films were analyzed by atomic force microscopy (AFM) to study their roughness. The films were found to be generally smooth, but the surface roughness increased from 6 nm to 12 nm (RMS) as the precursor concentration increased from 0.05 M to 0.30 M, with maximum peak height (Sp) reaching up to 42 nm. Contact angle measurements revealed that the degree of hydrophobicity increased from 119° to 124° with increasing precursor concentrations. Electrical characterization by current-voltage measurements showed that the photocurrent to dark current ratio peaked at 34 for the precursor concentration of 0.15 M, compared to 17 and 22 for 0.05 M and 0.30 M, respectively, under a bias of 3 V and an excitation density of 100 mW/cm². These results reveal a strong correlation between precursor concentration and film morphology, wettability, and conductivity. Notably, the study provides a systematic analysis of how precursor concentration variations enable fine-tuning of Zn₂SnO₄ film properties, highlighting the versatility of the spray pyrolysis method and its potential for scalable production. This work contributes to scientific innovation by demonstrating how process parameters can be designed to optimize functional thin films for applications in optoelectronic and sensing devices.

Acknowledgments. This research was funded by Ministry of Education and Research from the Republic of Moldova, the Young Researchers 2025–2026 project #25.80012.5007.31TC.

S1-1.4 (713) Two Dipole-Dipole Interacting Emitters in a Moderately Strong Laser Field

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The cooperative resonance fluorescence spectrum for a non-resonantly laser-pumped pair of dipole-dipole coupled two-level radiators is explored. The dipoles are confined in a small volume within the Dicke limit, i.e., when the inter-emitter distance is much smaller than the emission wavelengths. Also, a non-trivial detuning between the laser and emitter transition frequencies is considered. Several approximations have been used, including the electric dipole approximation, the rotating wave approximation, and a rotating frame of reference taken at the laser's pumping frequency. The emitters are driven by a moderately strong coherent electromagnetic field, and the dipole-dipole coupling strength—having the dimension of frequency—significantly exceeds the collective decay rate while remaining much smaller than the doubled Rabi frequency. This frequency, manifested by the system is, in turn, much smaller than the emitter transition frequencies. We obtained the characteristic two-qubit Mollow spectrum consisting of the elastic part and, respectively, the spontaneous resonance fluorescence part of the spectrum, i.e., the central, as well as the left and the right spectral bands. The study discusses the vanishing elastic part of the spectrum and the dressed states dipole-dipole interaction. It shows the proper analytic ratio between the non-zero detuning of the system and the doubled Rabi frequency to achieve the ensuing result.

S1-1.5 (792) Polymer-Coated Cd-Doped ZnO Nanostructures for Dual Sensing of Volatile Organic Compounds and Battery Vapours

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Cost-effective sensor fabrication methods are characterized by their simplicity, requiring minimal processing steps to produce nanomaterial-based devices capable of detecting volatile organic compounds (VOCs) and battery-emitted vapours for various applications in environmental and healthcare fields. In this work, we present a sensor based on Cd-doped zinc oxide (ZnO:Cd) nanocolumns synthesized via a solution chemical synthesis (SCS) method and coated with a poly ethylene glycol dimethacrylate (PEGDMA) layer. The resulting composite device exhibits a novel dual-temperature functionality, enabling the detection of 2-propanol (response up to ~58%) at higher operating temperatures (350°C), while nearly doubling the selectivity over *n*-butanol compared to the uncoated sensor. It also detects the critical battery vapour 1,3-dioxolane (C₃H₆O₂, response up to ~18%) at lower temperatures (150°C). Crucially, the PEGDMA coating dramatically improved sensor kinetics, reducing the recovery time for 2-propanol at 250°C from over 42 s to approximately 8 s. The presence of Zn, O and Cd atoms was confirmed through energy-dispersive X-ray spectroscopy (EDX), while the conformal polymer coverage was verified via morphological characterization in scanning electron microscope (SEM). The obtained experimental results are important for EV industrial, biomedical and space nanosatellites applications, demonstrating a clear pathway for developing versatile, multi-purpose sensors with tailored operational modes.

S1-1.6 (758) Synthesis, Structure and Properties of a Linear Trinuclear Co(II) Isobutyrate Cluster with 1,10'-Phenanthroline

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A new trinuclear cluster $[\text{Co}_3(\text{ib})_6(\text{phen})_2]$ (where Hib = isobutyric acid, phen = 1,10'-phenanthroline) has been obtained and characterized by elemental analysis, IR spectroscopy, ESI-MS spectrometry, and thermogravimetric studies. This can be achieved simultaneously by synthesis methods such as stirring and ultrasonic irradiation. The structure of the trinuclear Co(II) cluster has been solved by single-crystal X-ray diffraction measurements, revealing a centrosymmetric linear arrangement of three Co(II) atoms bridged by six isobutyrate moieties. Four of these moieties act in a bidentate syn-syn fashion, bridging two Co atoms, while the remaining two serve as bidentate chelate-bridging units. The central Co atom resides at the crystallographic center of symmetry and is coordinated by six O atoms from six isobutyrate, resulting in an octahedral O_6 surrounding. The coordination sphere of the peripheral Co atoms is completed by three isobutyrate ligands, two of which coordinate in a monodentate fashion and one in a chelate bidentate mode, and 1,10'-phenanthroline, providing a distorted octahedral N_2O_4 surrounding. Hirshfeld surface analysis was performed to elucidate the intermolecular interactions contributing to the stabilization of the crystal structure. Magnetic measurements show ferromagnetic exchange interactions between the high spin Co(II) centers.

S1-1.7 (844) Ferroelectric $\text{Al}_{1-x}\text{Sc}_x\text{N}$ Thin Films for Memory and Computing Applications (Invited)

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The discovery and development of the new wurtzite-type nitride ferroelectrics, such as AlScN and GaScN , has attracted attention due to their ferroelectric properties, like large remanent polarization, large coercive fields, as well as their compatibility with both CMOS and GaN technology. The ferroelectric phase in these materials shows an exceptional temperature stability that surpasses 1100°C.

$\text{Al}_{1-x}\text{Sc}_x\text{N}$ polycrystalline thin films having a columnar structure and showing a typical fiber texture were obtained by reactive magnetron sputtering deposition on Pt electrode layers on thermally oxidized silicon substrates. Epitaxial nitride ferroelectric films were obtained by growing the films on epitaxial Pt electrode layers deposited on $\text{GaN}/\text{Al}_2\text{O}_3$ substrates or directly on n-type doped n-GaN/ Al_2O_3 substrates. The $\text{Al}_{1-x}\text{Sc}_x\text{N}$ film thickness was varied between 4 and 300 nm, grown by magnetron sputtering on standard Si wafers or epitaxial templates [1]. The Sc concentrations in the analyzed films ranged from $x = 0.15$ to $x = 0.30$.

The structural characterization of the samples was performed by scanning transmission electron microscopy (STEM) and x-ray diffraction. Ferroelectricity in $\text{Al}_{1-x}\text{Sc}_x\text{N}$ films as thin as 4 nm was proved [2].

The polarization direction of the as-grown films (metal polar or nitrogen polar) is analysed through electrical measurements correlated with STEM structural analysis, for various combinations of top and bottom electrodes and different film thicknesses. Thus, it is shown that the sputtered $\text{Al}_{1-x}\text{Sc}_x\text{N}$ films on Pt electrodes usually have an as-grown N-polar polarization orientation, whereas the films deposited on the M-polar GaN template have an M-polar initial polarity up to a film thickness of about 30 nm. For films thicker than 40 nm, the presence of N-

polarity is observed, so there is a transition from as-grown M- to N-polarity at a thickness between 30 and 40 nm. These results were confirmed by experiments with highly selective etching (phosphoric acid) of as-deposited and electrically N-polar switched regions.

The evolution of the epitaxial strain imposed by the GaN template on the $\text{Al}_{1-x}\text{Sc}_x\text{N}$ films is analyzed. Thus, at 28 at.% Sc, films up to ≈ 40 nm thickness are fully strained to the GaN, while for thicker films, the extent of the fully strained regime decreases with increasing film thickness [1]. By reducing the Sc concentration from 28 to about 8 at%, lattice-mismatched conditions are obtained.

Ferroelectric domain walls in $\text{Al}_{1-x}\text{Sc}_x\text{N}$ are inclined with respect to the c-axis and expected to be charged, and the compensating charges possess sufficient mobility to be employed in resistive switching devices [3].

Thus, a new type of memristive devices based on the reshaping of conductive ferroelectric domain walls in these films is developed and discussed in this contribution. These types of devices are promising for neuromorphic computing applications since they can mimic the synaptic weights in biological systems.

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S1-1.8 (739) Direct and Indirect Transitions in the Luminescence of SnS_2

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The luminescence properties of SnS_2 single crystals were studied in the absorption edge region at room temperature and at low temperature (10 K). The band structure near the band gap minimum was clarified by studying the luminescence of SnS_2 crystals. The band gap minimum is determined by indirect transitions from the L to Γ points of the Brillouin zone ($E_g = 2.324$ eV at 300 K). At an energy of 2.400 eV, indirect transitions from the M to Γ points occur. Direct electron transitions in the Brillouin zone - C_1-V_1 in $E\parallel b$ polarization (2.690 eV) and C_1-V_2 in $E\perp b$ polarization (2.846 eV) - also appear in the luminescence spectra. The most intense luminescence maximum was detected at 3.263 eV (300 K) and is associated with the C_1-V_3 transitions. At low temperatures (10 K), the maximum E_g at 3.362 eV, due to C_1-V_4 transitions, appears with weaker intensity. A colloidal solution of SnS_2 quantum dots luminesces at 300 K over a wide energy range. By changing the size of the quantum dots, the luminescence region can be shifted. The main contribution to the luminescence of quantum dots of layered SnS_2 is due to direct transitions at the center of the Brillouin zone.

S1-1.9 (764) Numerical Simulation of the Generation of Picosecond Pulses with Gain-Switched DFB Lasers

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We discuss the numerical generation of picosecond pulses in gain-switched distributed feedback (DFB) lasers using the traveling-wave equation model. The principle of pulse generation is discussed, which consists of injection of trapezoidal - shaped injected current, which leads to an fast increase in carrier density, followed by an abrupt decrease that result in a pulse shape of the output power. We report improvements in the shape and peak of the pulses, as well as a reduction of pulse width. Our findings suggest that these lasers can produce pulses with a peak power exceeding 1.0 W and a pulse width of less than 10 ps. We investigated the effect of various parameters, such as injected currents, the width of the active region, the pulse length of the trapezoid of injected current, and both the rise and fall times of the injected current affect the primary pulse characteristics, including peak power, energy, and full width of half maximum (FWHM). We present a set of geometrical and material parameters for a system, that could provide an experimental demonstration of the theoretical results ob-tained. Finally, we identified the optimal parameters for applications requiring short pulses.

S1-1.10 (765) Numerical Investigation of Properties of Picosecond Pulses in InGaN Lasers under Q-switching Operation

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This paper presents a theoretical investigation of picosecond pulse generation in blue-violet InGaN semiconductor lasers with an additional saturable absorber (SA) under a Q-switching mechanism. This study addresses the increasing demand for compact, high-performance pulsed sources in fields such as medical diagnostics, imaging, dermatology, and laser-assisted surgery, etc. We describe the laser structure. Special attention is given to this new laser configuration that is proposed in this paper. The difference to previous structures is that in our case the SA is located in the outer regions of laser and can be controlled by a small injected current. We mention that such devices could be realized experimentally. The theoretical framework is based on rate equation model. We begin our analysis with the principles of pulse generation. We perform numerical simulations to analyze the main pulse characteristics, such as peak power, pulse energy, and full width at half maximum (FWHM), as a function of various structural and material parameters, such as SA length, losses in the full device, and back facet reflectivity. These results provide valuable guidance for optimizing the design and operation of InGaN-based Q-switched laser sources for different applications.

S1-1.11 (770) Birefringence Mapping of Diffractive Optical Elements on Gold-Doped Azopolymer Nanocomposites by Polarization Digital Holographic Microscopy

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This study investigates the birefringence behavior of diffractive optical elements (DOEs) recorded on gold-doped photosensitive azopolymer nanocomposite thin films, employing polarization digital holographic microscopy (PDHM) in combination with Jones transmission matrix analysis. Nanocomposite films were fabricated from a toluene solution of doped carbazole-based photosensitive azopolymer with a number of varying concentrations of gold nanoparticles (AuNPs). DOEs were directly inscribed via polarization-sensitive holographic recording, and their birefringent properties were mapped in three dimensions using a custom-built PDHM system equipped with a Kiralux polarization camera. The reconstructed phase and amplitude data were further analyzed through spatially resolved Jones matrix calculations by MATLAB code, enabling a quantitative evaluation of local birefringence parameters, such as retardance and optical axis orientation. Results demonstrate a clear dependency of birefringence on AuNP concentration, with higher doping levels significantly enhancing molecular reorientation efficiency and induced anisotropy during the holographic recording process. Jones transmission matrix analysis revealed distinct polarization modulation patterns across the recorded DOEs. The integration of PDHM with Jones matrix formalism offers a robust and non-invasive methodology for detailed birefringence characterization in advanced photoactive nanocomposites. This approach not only advances the understanding of the optical response in AuNP-doped azopolymers but also supports the development of customizable, polarization-sensitive diffractive components for modern photonic applications.

S1-1.12 (846) Scientific Progress in Perovskite Materials, A Game Changer in Photovoltaics

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Over the past century, rapid global population growth has placed immense pressure on energy and natural resources. This expansion has been accompanied by increasing greenhouse gas emissions, air and water pollution, and the acceleration of climate change. To address these challenges, the United Nations Sustainable Development Goals (SDGs) emphasize the urgent need for clean, accessible, and carbon-neutral energy solutions. Achieving the SDGs requires science-driven innovation in renewable energy technologies, with solar energy standing out as the most abundant, clean, and universally accessible resource. Photovoltaics, which directly convert sunlight into electricity, play a central role in this transition.

A major scientific breakthrough in this field was the introduction of perovskite materials for solar cells in Japan in 2009. Since then, perovskite photovoltaics have transformed global solar research, with power conversion efficiencies rising dramatically from 3.8% to over 26% in just over a decade—surpassing traditional silicon solar cells. This rapid progress is due to their remarkable optoelectronic properties: strong light absorption, tunable bandgaps, low weight, flexibility, and compatibility with scalable, low-temperature solution processing.

Despite these achievements, important challenges remain. Long-term stability, lead toxicity, and reliable large-scale production continue to limit commercialization and are the focus of intense scientific investigation. Motivated by these limitations, my current research explores alternative, environmentally friendly chalcogenide absorbers. Recently, I developed a simple solution-based

synthesis of silver–bismuth sulfide (AgBiS₂) films. The resulting film exhibits a high crystallinity, cubic crystal structure with a bandgap of around 0.95 eV. In the device, AgBiS₂ achieved an extremely high photocurrent density of 39.2 mA cm⁻², the highest reported to date for AgBiS₂ films prepared via a simple solution-based process. Under maximum power point tracking, these devices retained 99% of their initial efficiency without observable degradation after 24 hours, demonstrating their potential as robust and sustainable solar absorbers.

In this talk, I will present the scientific progress of perovskite photovoltaics and outline current academic research directions, highlighting how advances in materials science can help address the global energy challenges.

S1-2.1 (845) Advanced Biomaterials in Tissue Engineering: A Critical Review of Nanocomposites Based on Bacterial Cellulose, MXenes, Hydroxyapatite, and Metal Particles for Regenerative Medicine *(Invited)*

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Soft and hard tissues have limited regenerative potential that fuels the search for advanced biomaterials able to mimic their complex dynamics better. Individually, bacterial cellulose (BC) provides excellent biocompatibility but lacks inherent bioactivity and functional properties needed to promote tissue regeneration. Hydroxyapatite (HAp) offers osteoconductivity but shows brittleness. Metal nanoparticles (MNPs) have antioxidant, antimicrobial, and drug-delivery properties, but may be toxic. Lastly, MXenes possess good conductivity but lack knowledge of their long-term biocompatibility. To address these material limitations, approaches like genetic modifications to BC synthesis and surface modifications of MXenes and MNPs are explored. This review examines synthesis methods, structural properties, and biomedical applications of individual and hybrid materials based on BC, MXene, HAp, and MNPs. Analysis of existing composite materials establishes a strong recognition of their compatibility, which supports the possibility of their successful integration into a multifunctional BC/MXene/MNP/HAp four-component composite. It is expected to exhibit a combination of osteoinduction, electrical conductivity, antibacterial activity, and structural support to improve tissue repair. However, challenges include the potential cytotoxicity of MNPs and limited studies on the broader impact of MXenes on gene expression beyond specific markers. This review sheds light on the development of a new composite material that can address current limitations in biomaterial functionality by summarizing current knowledge and highlighting critical gaps. It aims to establish a foundation and inspire future studies toward rationally designing BC/MXene/MNP/HAp composites for advanced regenerative therapies.

S1-2.2 (773) Superconducting Components for Brain-Inspired Neural Networks: Spintronic Innovations for Neuromorphic Computing

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With the growing energy demands of modern computers based on von Neumann architecture, the need for more energy-efficient computing solutions has become increasingly urgent. This has led to a shift towards non-von Neumann computing paradigms, particularly those inspired by the brain's neural network architecture. Artificial Neural Networks (ANNs), which emulate the structure and function of biological neurons and synapses, have gained significant attention in this context. These networks, when built on superconducting elements, promise a dramatic reduction in energy consumption, addressing the key limitations of current semiconductor-based computing systems. In this work, we investigate superconducting artificial neurons based on superconducting spin valves and artificial synapses composed of hybrid nanostructures. The study focuses on superconductor/ferromagnet layered hybrid nanostructures, highlighting their potential in superconducting spintronics and energy-efficient computing. Study of proximity effect in the multilayer superconductor/ferromagnetic (S/F) nanostructures with ferromagnetic Co layers of various thicknesses and coercive fields, as well as superconducting Nb layers of constant thickness equal to the coherence length of superconductor were done and analysed. The results of the design and research of artificial neurons based on superconducting spin valves and superconducting synapses based on superconductor-ferromagnetic Nb/Co hybrid nanostructures are presented.

S1-2.3 (775) How Semiconductor Terminology has been Enriched by Research of Electrochemical Pore Etching and Electrodeposition

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Electrochemical pore etching, initially developed for silicon substrates, has progressively been extended to a wide range of semiconductor compounds, such as binary III-V and II-VI materials. This technique enables the formation of highly controlled porous architectures with tunable geometries, which are increasingly relevant for applications in photonics, sensing, energy conversion, and nanofabrication. While the historical development of pore etching technologies has been extensively reviewed in the literature, the present article highlights a specific regional contribution to this field: the sustained efforts of Moldovan researchers in advancing both the scientific understanding and technological applications of porous semiconductors. Special attention is given to the research conducted at the National Center for Materials Study and Testing of the Technical University of Moldova, which has significantly contributed to elucidating pore formation mechanisms in crystalline semiconductors and to the development of ordered porous structures with tailored properties. Research efforts in this area have resulted in the development of nanoporous networks exhibiting selective transport characteristics and complex interconnectivity, opening pathways to novel functionalities. Studies on metal deposition within these nanostructures have introduced new concepts such as hopping electrodeposition, allowing the formation of hybrid metal-semiconductor architectures. Additionally, the integration of anodic etching with self-organization phenomena has enabled the generation of highly ordered porous arrays with reproducible characteristics. These advances are not only relevant for fundamental studies but also open promising directions for the design of next-generation optoelectronic and catalytic devices. The review places these achievements in an international context and underlines their impact on the evolution of electrochemical nanostructuring.

S1-2.4 (778) Hybrid Nanomaterials for Biomedical Sensors

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The energy industry is transitioning towards green and ecological power sources, and as a result there is a growing need for hydrogen detectors, which serves as clean and versatile energy carriers. On the other hand, biomedical diagnostics is currently researching various biomarkers exhaled in breath, such as ammonia, 2-propanol, acetone and hydrogen. In this work, Al₂O₃/CuO gas sensing structure coated with ZIF-8 has been studied for selective enhancement of sensing response for acetone vapor at an operating temperature of 275 and 300°C. Composite metal-oxide has a granular structure which improves contact with detected gases. XRD study shows the presence of three different phases (CuO, Cu₂O, and CuAl₂O₄) of copper oxide structures following the deposition of the Al₂O₃ on it. EDX shows a homogenous distribution of elements and confirms the elemental composition of Al₂O₃/CuO films. The ZIF-8 coated Al₂O₃/CuO nanostructures shows highest gas sensing response (105%) to acetone at an operating temperature of 300°C with a response and recovery times of 7 s and 43 s, respectively. On the other hand, the gas sensing response (85%) for hydrogen gas was observed at 300°C with a response and recovery times of 3 s and 9 s, respectively. This work results indicate a way to enhance gas sensing performance by using hybrid nanomaterials, including Al₂O₃/CuO films with ZIF-8 coating. The electrostatic interaction occurs between the oxygen in the carbonyl group with the metal center (Zn²⁺) of ZIF-8. The hybrid structures developed here are very important for hydrogen gas detectors, given their dual role in implementing clean energy solutions and improving breath-based biomedical diagnostics.

S1-2.5 (794) Applications Photosensitive Nanocomposites for Direct Holographic Recording

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Azopolymers are materials that exhibit photoinduced anisotropy, enabling the direct holographic recording of diffraction gratings with selective polarization. The use of nanocomposite materials, in particular the doping of azopolymers with gold nanoparticles, can alter the properties of the azopolymers. One of the most significant effects is the enhancement of photoinduced birefringence, which leads to increased diffraction efficiency. The spectral photosensitivity of the fabricated nanocomposites enabled the use of the blue-green region of the laser spectrum for recording holographic diffraction gratings, while the red wavelength, lying within the transparency region of the material, was used for monitoring the grating recording kinetics and measuring the diffraction efficiency.

This paper presents a study on the kinetics of diffraction efficiency and polarimetric parameters (azimuth and ellipticity) of diffraction gratings in thin films of azopolymer Poly-n-epoxypropylcarbazole – Solvent Yellow 3 (PEPC-SY3) doped with gold nanoparticles (0–1 µg/ml). Holographic diffraction gratings were recorded using laser radiation with a wavelength of 473 nm and various polarizations of the recording beams, including linear (P:P, ±45°) and circular (LCP:RCP) polarizations. Significant variations in azimuth and ellipticity were also observed,

indicating local changes in the refractive index caused by the formation of periodic surface and volume structures in the nanocomposite film.

This work presents results on the dynamic changes in the polarization of a beam transmitted through the material during holographic recording of diffraction gratings. It allows one to observe the processes that occur due to photo-induced anisotropy—specifically, changes in the azimuth and ellipticity of the transmitted beam—as well as to practically optimize and control polarization-sensitive holograms. This opens pathways for the development of advanced diffractive optical elements and high-density data storage systems.

S1-2.6 (795) Di- and Trinuclear Cu(II) Isobutyrate Complexes: Synthesis, Structure and Biological Activity

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Three new copper(II)-based coordination compounds namely $[\text{Cu}_2(\text{ib})_4(\text{dmsO})_2]$ (1), $[\text{Cu}_2(\text{ib})_4(4\text{-pyca})_2]$ (2), and $[\text{Cu}_3(\text{ib})_4(\text{H}_2\text{tea})_2]$ (3), where Hib = isobutyric acid, 4-pyca = 4-pyridinecarboxaldehyde, H_3tea = triethanolamine, have been synthesized and characterized by IR spectroscopy and thermogravimetric studies. Single-crystal X-ray diffraction analysis revealed that compounds 1 and 2 adopt binuclear structures where the four isobutyrate ligands bridge the Cu(II) atoms in a paddlewheel dimer. The square-pyramidal coordination surrounding of the Cu(II) atoms is provided by the coordination in the apical position of dmsO in 1 or 4-pyca in 2. Compound 3 is a trinuclear linear cluster with Cu(II) atoms connected by bridging carboxylate and triethanolamine ligands. In 3, each Cu(II) ion has a square-bipyramidal environment where six oxygen atoms surround the central Cu(II) atom and five oxygen atoms and one nitrogen atom surround the peripheral atoms of Cu(II). Hirshfeld surface analysis was employed to elucidate the nature of intermolecular interactions within the crystal lattice. The results indicated a predominance of $\text{H}\cdots\text{H}$ contacts, accompanied by significant $\text{H}\cdots\text{O}/\text{O}\cdots\text{H}$ interactions, suggesting the presence of hydrogen-bonding networks that contribute to the stabilization and packing of the complexes. The synthesized compounds were evaluated *in vitro* against the oncogenic bacterium *Rhizobium* (Agrobacterium) *vitis*, which is responsible for plant tumor formation. The results suggest that these compounds exhibit antibacterial activity, opening prospects for their use in plant protection.

S1-2.7 (776) Low Power MM-Wave Radiometer Technology for Earth Observation Space Missions (Invited)

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Climate change imposes prerogative tasks to space missions for climate research and weather forecast. ESA, NASA and many other national space agencies push development of mm-wave radiometer technology for Earth Observation.

MM-wave Direct Detection Radiometers (DDR) are very promising instruments for Earth Observation space missions on climate research. Several national space agencies in Europe led by ESA push development of European mm-wave DDR technology during last two decades through a number of dedicated R&D activities and studies. All these efforts were targeting at one of the most significant space missions of ESA, called MetOp-SG. DDR technology has considerably advanced and nowadays is standardly employed for an important frequency channel at 89GHz in several space missions for Earth Observation (EO) not only in Europe but also in the USA, Japan, China, and other countries. This progress could not be realized without great ambition and commitment of ESA and space related companies in Europe.

Nowadays ESA and space related European companies push further development towards extension of DDR technology to other important frequency channels for Climate research.0

S1-2.8 (760) Formation of Zinc Oxide Buried Layers within the Walls of the Aero-GaN Microtubes

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This work reports on the innovative fabrication and detailed characterization of aerogalnite (aero-GaN) microtubes featuring encapsulated zinc oxide (ZnO) layers. These distinctive buried ZnO layers emerge during a carefully controlled Gallium Nitride (GaN) growth process conducted via hydride vapor phase epitaxy (HVPE) on an interconnected, three-dimensional ZnO microtetrapod network employed as a sacrificial template. The complex synthetic route involves two stages at different temperatures. Initially, at low-temperature (600°C) the nucleation and growth phase of epitaxial GaN layer occurs, followed by a high-temperature (850°C) growth regime to accelerate GaN film formation. Intriguingly, this high-temperature phase also induces the controlled decomposition and subsequent removal of the ZnO template. Comprehensive transmission electron microscopy (TEM) studies reveal that, despite the extensive removal of the sacrificial ZnO template, an exceptionally thin ZnO layer persists at on the inner surface of the resulting GaN microtubes. Critically, this interfacial ZnO film subsequently becomes wholly encapsulated, forming well-defined, spatially discrete buried layers within the evolving GaN structure as the aerogalnite process continues. The resulting aerogalnite structure, bearing these meticulously crafted ZnO/GaN heterojunctions with a minimized lattice mismatch, presents possibilities for the future exploration of novel material properties and advanced device designs. The creation of buried ZnO layers may permit an unprecedented degree of modulation of the GaN microtube interface characteristics, opening diverse pathways towards tailored electronic and optoelectronic properties.

S1-2.9 (809) Performance of Ag₂S/ZnO Nanostructures in Radiation Monitoring

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UV radiation is now of key importance in many fields such as medicine, agriculture, and the integrated circuit manufacturing industry. This use is felt not only in manufacturing processes, but also in the everyday life of every person who has at least once been to the dentist or consumed food pasteurized by the non-thermal method. For this reason, it is very important to control their usage time, as UV rays have both positive and negative effects. In the context of the increasing demand for UV sensors with superior performance, this work investigates the response of Ag₂S/ZnO nanostructures to a specific wavelength of 370 nm, revealing a signal almost five times more intense than that obtained at other wavelengths in the ultraviolet spectrum (280–430 nm). For the preparation of these nanostructures, an economical method was used, followed by heat treatment, ensuring the formation of uniform Ag₂S nanoparticles arranged on the surface of ZnO columnar crystals. Morphological and compositional characterization was performed by scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDX), revealing a homogeneous distribution of elements and a porous structure that enhances the surface-to-volume ratio. The response and recovery times of the sensor were also measured and values in the order of one second were obtained, recommending these nanostructures for applications in rapid detection and real-time monitoring of UV radiation intensity.

S1-2.10 (816) Cooperative Generation of Biomolecular complexes Under UVC Radiation, Application in Decontamination and Diagnostics

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The investigation provides a detailed analysis of the quantum mechanisms by which Raman pulses interacts with DNA/RNA and proteins biomolecules, emphasizing of bounding of super molecular structures synthesized from tertiary protein components. A nonlinear model was developed based on cooperative processes similar to Raman multiple scattering, in integrating with bio-molecular structures. Taking into consideration the possible packing protein structures, a main attention is given to Kasha model stimulated by multiple Raman Conversion. The excited states for trimer, tetramer and pentamer are give for the evidence of existing stable exciton state in such supra-structures coherently generated by Raman conversion. The master equation which describe the synthesis of such a stable structures under the Raman excitation is proposed. Two possibilities of generation of quantum states between bonding and unboding super molecular states a proposed. This investigation may have highlights practical applications in the development of high-e-ciency

in the construction of modern decontamination equipment using advanced optical metamaterials. The dependence of decontamination rate of pathogens as function of applied eld is proposed. In experimental equipment Instead of pathogens we used the yeast fungi which have larger resistance in comparison with pathogens (viruses and bacteria). The two decontamination rates as function of applied ultraviolet C radiation was observed in nanosecond pulse interaction with yeast biomolecules, which may be explained by proposed multiple Raman dimerization model of biomolecules.

S1-2.11 (729) Comparison of Emission Properties of Water-Soluble Mono- and Tetra- o-(Carboxybenzamidometilen)PcZn Derivatives

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The development of phthalocyanine derivatives with enhanced photophysical properties is crucial for advancing applications in optoelectronics, photodynamic therapy (PDT), and other medical fields. In this study, we investigated the photophysical properties of two zinc phthalocyanine derivatives: mono-(o-carboxybenzamidomethylene) (mono-CBAM-PcZn) and tetra-(o-carboxybenzamidomethylene) (tetra-CBAM-PcZn), both solubilized in water to facilitate biomedical applicability. The absorption spectra of both derivatives showed characteristic Q- and Soret bands, with tetra-CBAM-PcZn displaying red-shifted absorption features at 812 nm compared to mono-CBAM-PcZn, indicating an extended π -conjugation and potential for deeper tissue penetration in PDT. Fluorescence measurements revealed a significant increase in the quantum yield fluorescence from 10.08% for mono-CBAM-PcZn to 22.02% for tetra-CBAM-PcZn, accompanied by shorter fluorescence decay lifetimes for the tetra-substituted derivative, indicating faster radiative deactivation pathways. Both derivatives exhibited room-temperature phosphorescence in the 375–650 nm region, with an additional peak at 690 nm observed for mono-CBAM-PcZn, suggesting differences in triplet-state deactivation mechanisms. Transient absorption studies demonstrated that tetra-CBAM-PcZn exhibits stronger triplet-state absorption than mono-CBAM-PcZn, an indicative of more efficient intersystem crossing and enhanced triplet-state population. These findings suggest that the tetra-substituted compound shows more efficient energy transfer processes and better suitability for applications in PDT and bioimaging, particularly due to its increased fluorescence quantum yield, favorable absorption properties in the tissue transparency region (600–800 nm), and enhanced triplet-state characteristics.

S1-2.12 (787) Effect of PTFE Thickness on Gas Sensing Properties of TiO₂/Pd-Doped ZnO Nanostructures

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A key challenge for modern nano-industry is to produce precise, cost-efficient, multipurpose nano-devices, as there are a lot of fields demanding progress. Thus, gas sensors are coming in a various spectra of characteristics based on different material combinations for specific tasks. In this paper, a sensor based on ZnO, TiO₂, Pd nanoparticles and Polytetrafluoroethylene (PTFE) coating showed interesting results for hydrogen, 2-propanol and n-butanol detection. Different selectivity was achieved by varying the thickness of the PTFE layer. Thus initially, a 40 nm layer at operating temperature of 300 °C showed selectivity towards n-butanol and at 250 °C towards hydrogen gas. After 3 months, it maintained selectivity towards hydrogen gas at 250 °C and improved considerably selectivity towards 2-propanol at 300 °C. Similarly, a 100 nm PTFE layer yields selectivity towards 2-propanol at 300 °C and acetone at 350 °C, while after 3 months repeated measurements showed increased selectivity towards hydrogen at 300 °C and 2-propanol at operating temperature of 350 °C. The sensor reveals how variations in polymer coating thickness modulate gas selectivity through structural effects, while still proving by maintaining selectivity of both samples after a period of 3 months that these results can be reproduced. This paper offers new prospects of polymer thickness influence on both selectivity and sensitivity while offering methods of how to tune initial sensors towards a target analyte. Such sensors are necessary to research and produce for further improvements in biomedical applications to attain a certain threshold for non-invasive diagnosis.

S1-2.13 (725) Two Qubits in Thermostat

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The quantum dynamics of two dipole-dipole coupled two-level emitters interacting via their environmental thermostat is investigated. Using collective two-atom Dicke states for the case when dipole-dipole interactions are strong, but less than the transition frequency, we derived the corresponding markovian master equation characterizing the steady-state system's behaviors. It takes into account the dependence of the spontaneous decay rates as well as of the mean photon numbers (which we get by tracing the reservoir), at respective two-qubit transitions, on the dipole-dipole coupling strength. As a consequence, we have obtained the cooperative populations as well as the fluorescence spectrum of the dipole-dipole coupled two-qubit sample interacting with the environmental thermostat. The ratios of the populations on adjacent transitions differ from the Boltzmann distribution since depend on the dipole-dipole interaction among the qubit's pair. As well, the fluorescence spectrum in the far-field limit consisting of two spectral lines which are distinguished if the dipole-dipole coupling is larger than the collective spontaneous decay rates, respectively. Finally, the dependence on the dipole-dipole interactions arise because the symmetrical and anti-symmetrical collective two- qubit states are shifted from the single-qubit resonance frequency by the dipole-dipole coupling strength. Hence their dependence on the sign of the dipole-dipole interaction.

S1-P1 (690) Characterization of ALD TiO₂ Films on Nanostructured Black Silicon Layer

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In this work, thin titanium dioxide (TiO₂) films were synthesized by atomic layer deposition (ALD) on p-type monocrystalline silicon substrates with planar and nanostructured surfaces. The nanostructured black silicon (b-Si) layer was fabricated using maskless reactive ion etching in an SF₆/O₂ gas mixture, resulting in an array of conical nanoneedles with high surface area. The structural, optical, and electronic properties of the TiO₂/Si and TiO₂/b-Si/Si heterostructures were comprehensively characterized by scanning electron microscopy, energy-dispersive X-ray spectroscopy, X-ray diffraction, as well as current-voltage and spectral responsivity measurements. The results revealed that the ALD TiO₂ films crystallize in the anatase phase and provide conformal coverage on both planar and nanostructured surfaces. The b-Si layer increases the ALD TiO₂ crystallite size from 31 to 42 nm and reduces the optical reflectance by 4–5 times in the visible and near-infrared ranges. Electrical measurements demonstrated enhanced photocurrent and a shift in the spectral responsivity maximum to the visible region (up to 0.28 A/W at 500–600 nm) for TiO₂/b-Si/Si heterostructures, attributed to improved light absorption and increased contact area. However, the nanostructured b-Si layer also leads to a higher reverse current and a decrease in the potential barrier height from 0.83 to 0.68 eV, indicating the need for nanostructure optimization to minimize recombination losses. These findings highlight the potential of TiO₂/b-Si/Si heterostructures for high-efficiency optoelectronic devices, including solar cells and broadband photodetectors.

S1-P2 (699) Enhancing the Conductivity of Al-Doped ZnMgO Films via Aerosol Deposition Method

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In this paper, we investigate the conductivity enhancement in Zn_{1-x}Mg_xO₂ thin films with variable aluminum (Al) concentration deposited by spray pyrolysis on silicon (Si) substrates. The morphology of the films was investigated using scanning electron microscopy (SEM), and their chemical composition was analyzed using energy-dispersive X-ray spectroscopy (EDX). The average crystallite size in Zn_{0.95}Mg_{0.05}O films was 105 nm, while in Zn_{0.85}Mg_{0.15}O films it decreased to 40 nm, according to SEM analysis. Atomic force microscopy (AFM) measurements showed a decrease in the root mean square (RMS) surface roughness from 44 nm to 12 nm as the Mg concentration increased. X-ray diffraction (XRD) analysis revealed that the crystalline structure of the films remained largely unaffected at lower Mg concentrations. The electrical properties of ZnMgO:Al thin films were evaluated by measuring the current-voltage (I-V) characteristics in the dark, in a voltage range from 0.1 V to 5 V. The results indicated that films with an optimal Al concentration of 1% exhibited the highest conductivity. After a vacuum heat treatment for one hour at 400 °C, the conductivity of films increased by a factor of 15 (at 1% Al). These results demonstrate the potential of Al-doped ZnMgO thin films as efficient transparent conductive materials, particularly when optimized with appropriate Mg and Al concentrations and post-deposition annealing.

S1-P3 (711) Effect of Post-Heat Treatment on the Physical Properties of CuO Films

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Nanometric CuO and Cu₂O films were manufactured by high temperature magnetron sputtering (T=400 °C) and possess properties that make them suitable as electron and hole transport films, respectively, in various types of solar cells, such as perovskite and organic, as well as in optoelectronic devices. In this study, the effect of oxygen flow on optical properties and the influence of post-deposition treatment on the topographical and connectivity characteristics of thin CuO and Cu₂O films were investigated. The surface topography was analyzed using atomic force microscopy (AFM), revealing an increase in surface roughness as the film thickness increased from 100 nm to 340 nm. Post-deposition heat treatment performed at T = 400 °C for 60 min under high vacuum conditions (~104 Torr) resulted in a substantial increase in the contact angle from 102° to 120°, indicating a transition to more hydrophobic surface behavior. The optical transparency of the investigated films was approximately 45% in the visible and near-infrared spectral range. The estimated bandgap values ranged from 1.54 to 1.67 eV and from 1.97 to 2.22 eV for Cu₂O films. Optimizing the thickness of the films, as well as their structural and electronic properties (e.g., grain size and charge mobility properties), can lead to significant improvements in the performance of the films obtained.

S1-P4 (728) Effect of Solvent on Photophysical Properties of Tetranitro Zinc Phthalocyanine

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This study investigates the influence of solvent on the photophysical properties of a tetranitro zinc phthalocyanine derivative synthesized through a cyclotetramerization reaction using 4-nitrophthalonitrile and zinc acetate in N,N-dimethylaminoethanol. Its photophysical behavior was systematically analyzed in DMSO, DMSO:H₂O (1:1), NMP, and NMP:H₂O (1:1) media using UV-Vis absorption, fluorescence, and phosphorescence spectroscopy. The UV-Vis spectra revealed the presence of a single, intense Q-band around 700 nm, whose position and intensity depend on the solvent polarity and the degree of hydrogen bonding, indicating solvent-dependent aggregation behavior. Fluorescence measurements showed well-defined emission bands only in pure solvents (DMSO and NMP), while in aqueous mixtures the fluorescence was strongly quenched, suggesting non-radiative processes and possible hydrogen-bond-assisted aggregation. Room-temperature phosphorescence, recorded under pulsed excitation with a xenon lamp, confirmed the population of triplet states, with emission bands around 850 nm and lifetimes on the order of tens of microseconds, depending on the solvent environment. The phosphorescence intensity was notably higher in DMSO compared to NMP, indicating differences in triplet-state stabilization. These results demonstrate that solvent polarity, hydrogen bonding, and the presence of water significantly influence both, singlet and triplet excited-state dynamics, of the tetranitro zinc phthalocyanine derivative. The findings provide valuable insights for optimizing the photophysical response of phthalocyanine-based systems in light-harvesting, photodynamic therapy, and optoelectronic applications, where solvent tuning can be employed to control emission properties and excited-state lifetimes.

S1-P5 (733) Electric Field-controlled Dynamics of Electron Localization in Pentamer Nanoclusters

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The theoretical model is proposed to describe the dynamics of localization of a shared electron in a pentamer nanocluster in the external low-frequency crossed electric fields, taking into account the electron-vibration interaction. When constructing this model, a semi-classical approach is used, in which a quantum description is applied to the electron subsystem, and the vibrational subsystem and the external electric field are described classically. Based on this model, a system of differential equations was obtained for the time dependences of the probability amplitudes of detecting an electron at different centers of the pentamer. This model is used to describe pentamers of planar-square and pyramidal configurations. For these two types of geometric configuration of pentamers, numerical calculations were carried out at different values of model parameters. The proposed model is characterized by the fact that the centers of the nanocluster are considered as weakly tunnel-coupled, and the electron-vibration interaction with the ligand environment at each of its centers plays a significant role. In this case, tunneling is taken into account only between the nearest centers of the nanocluster, and the centers themselves considered together with their ligand environment are considered equivalent. The controlling role of the external electric fields has been revealed, which consists in the fact that variations in its frequency and intensity amplitude allow the implementation of various regimes of electron localization in a pentamer nanocluster.

S1-P6 (756) PVP Modified ZnO and GaN Nanoparticles for Ceftriaxone Drug Delivery

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In this work, the possibility for use of GaN and ZnO nanoparticles as drug delivery systems is investigated. Both types of nanoparticles show a good crystallinity, according to the XRD analysis, and relatively good stability in suspension consisting of deionized water, especially after functionalization with Polyvinylpyrrolidone K30. The functionalization of nanoparticles with Polyvinylpyrrolidone leads to an increase of the average hydrodynamic size from 125 nm to 190 nm in case of ZnO, and from 180 nm to 340 nm in case of GaN, respectively. The results showed an increase of ceftriaxone adsorption on ZnO nanoparticles from 2.7 µg/mg in case of pristine nanoparticles, up to 5.5 µg/mg for the Polyvinylpyrrolidone modified nanoparticles. In case of GaN, the functionalization of nanoparticles leads to an increase from 0 to 4.5 µg/mg. The release of ceftriaxone from the surface of nanoparticles was tested in different media, namely in the PBS (pH = 7.4) and Acetate Buffer (pH = 5.8). It was found that less than 45 % of antibiotics are released in Acetate Buffer, while in PBS buffer, the drug molecules detach from the nanoparticles surfaces up to 90 %. Due to the unique properties of nanoparticles such as biocompatibility and piezoelectricity, the results are promising for the development of smart drug-delivery systems.

S1-P7 (763) Electrical Properties of the (Copper, Yttrium)-Containing Organometallic Compound as a Basis for Temperature and Magnetic Sensors in Biomedical Diagnostic Devices

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In this work, the authors have synthesised a new semiconductor material, pentakis(acetylacetonato) (copper(II), yttrium(III)) (I), with the following composition $[\text{CuY}(\text{AA})_5]$, where $\text{AA} = \text{H}_3\text{C}-\text{C}(\text{O})-\text{CH}=\text{C}(\text{O})-\text{CH}_3$. Based on elemental analysis and physicochemical methods, it was found that the complex compound (I) obtained contains atoms of yttrium(III) and copper(II) in the ratio $\text{Cu}:\text{Y} = 1:1$, and its composition corresponds to the empirical formula $\text{CuYO}_{10}\text{C}_{25}\text{H}_{35}$. The electrical conductivity of the obtained material was measured in pressed form. For the complex compound (I), the authors calculated that the number of valence electrons in one molecule is 200; the mass of one molecule is 107.558×10^{-20} kg; the total number of molecules in a cylindrical sample weighing 0.204 g and having a volume of 32.37×10^{-9} m³ is 18.967×10^{13} molecules. In the temperature range of 303 ~ 403 K, the resistivity of the pressed sample decreases from 2×10^{12} to 6×10^3 Ohm·cm. This confirms that the synthesised compound is a semiconductor with a band gap of 2.066 eV. The authors investigated the conductive properties of the complex compound as a thermosensitive element. For this purpose, the authors used an experimental sample of compressed material with geometric dimensions of $1 \times 10^{-3} \text{ m} \times 5 \times 10^{-3} \text{ m} \times 5 \times 10^{-3} \text{ m}$.

S1-P8 (769) Polarization Properties of Doe Recorded on Au-NPs Azopolymer Nanocomposites

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This work investigates the influence of incident light polarization on the holographic performance of azopolymer-based nanocomposites doped with gold nanoparticles (Au-NPs). Thin films of poly-N-epoxypropylcarbazole SY3 (PEPC-co-SY3) with different Au-NP concentrations were synthesized and subjected to holographic recording using various polarization configurations, including linear ($\pm 45^\circ$), circular (RCP/LCP), and vortex beams. The diffraction efficiency (DE) was analyzed in relation to the polarization state, beam structure, and Au-NP concentration. UV-Vis spectroscopy was employed to assess the changes in absorption and correlate them with holographic behavior. Results show a significant enhancement of DE due to the presence of Au-NPs, with maximum values up to ~40% under optimized conditions. Additionally, exposure to optical vortex beams led to unique light-induced modifications, suggesting the possibility to recording diffraction optical element (DOE), those are not achievable with conventional phase gratings. Moreover, the films exhibited a distinct anisotropic response, which was highly dependent on the polarization states of the beams used during the recording process. These findings support the potential of Au-NP azopolymer nanocomposites for advanced polarization-sensitive photonic applications.

S1-P9 (783) Anisotropic Thermoelectric Energy Converters Based on Single-Crystal Bi Microwires and Films

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We present a demonstration of a novel approach to thermoelectric energy conversion using a single element composed of an anisotropic material. In such materials, a heat flow induces a transverse thermoelectric field that is oriented perpendicular to the direction of the heat flow. A distinctive characteristic of anisotropic thermoelectrics is that the generated voltage is directly proportional to the anisotropy of the thermopower and the element's length, and inversely proportional to its effective thickness.

We fabricated an experimental sample of a heat flux sensor using a 10-meter-long, glass-insulated, single-crystal tin-doped bismuth microwire (outer diameter - 20 μm ; core diameter - 4 μm). A key factor in this process was the ability to grow the microwire as a single crystal, achieved through a laser-assisted recrystallization technique performed under a strong electric field. The microwire was coiled into a flat spiral and mounted onto a thin copper disk. This sample demonstrated high sensitivity to heat flow, reaching up to 10^{-2} V/W, with a time constant of approximately 0.2 seconds.

Polycrystalline bismuth films with thicknesses ranging from 2 to 5 μm were deposited onto mica substrates using a vacuum thermal evaporation technique. Experimental samples of heat flux sensors were then fabricated by recrystallizing these films under laser heating in a strong electric field. The observed voltage dynamics at the output of all sensors, in response to modulated heat fluxes, align well with theoretical predictions for anisotropic thermoelectric elements.

S1-P10 (793) Photoelectric and Optical Properties of Layered Compounds MgGaInS_4 and $\text{Mg}_{0.5}\text{Ga}_2\text{InS}_5$

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Single crystals of MgGaInS_4 and $\text{Mg}_{0.5}\text{Ga}_2\text{InS}_5$ with layered structure were obtained by a method of chemical vapor deposition with iodine as a transport agent. During the growth of single crystals, the temperature in the source zone was 880°C , and in the crystallization zone 820°C . A complete transfer of the charge was achieved within 12-14 days. The final product was a set of transparent lemon-yellow single-crystal plates 1-500 μm thick and up to 100 mm^2 in area. When exposed to air, the crystals do not show signs of interaction with oxygen or moisture and can be stored indefinitely long. The samples, like mica, could be easily split indicating their layered crystalline structure. X-ray studies showed that MgGaInS_4 crystallizes in a hexagonal lattice with parameters $a=3.8(1)$ Å and $c=30.6$ Å; $\text{Mg}_{0.5}\text{Ga}_2\text{InS}_5$ crystallizes in a hexagonal lattice with parameters $a = 3.8(1)$ Å and $c = 12.2(1)$ Å. The c axis runs along the direction perpendicular to the plates. Surface barrier structures Pt- MgGaInS_4 -In were manufactured. Photoelectrical and optical properties of MgGaInS_4 and $\text{Mg}_{0.5}\text{Ga}_2\text{InS}_5$ and surface barrier structures on their basis were investigated. Surface-barrier structures had a rectification coefficient of $10^2 - 10^3$ and generated photo-e.m.f. when illuminated, the maximum value of which was 300 mV. The photoresponse time of these structures in the photovoltaic mode is $\tau \approx 10^{-3}$ s.

S1-P11 (804) Multifunctional Bioactivity of Sulfated Spirulina Polysaccharides-Biofunctionalized Silver Nanoparticles in Tuberculosis: In Vitro Anti-Inflammatory and Immunomodulatory Effects on Lymphocytes from Patients with Diverse Mycobacterial Tuberculosis Strains

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Silver nanoparticles (AgNPs) show **promise as complementary agents** to standard anti-tuberculosis therapies, especially for **multidrug-resistant TB (MDR-TB)**. However, their **therapeutic effectiveness and safety** must be evaluated to ensure suitability for **clinical trials**. This study assessed **anti-inflammatory and immunomodulatory *in vitro* effects** of the *Spirulina-derived polysaccharides* (SPSp)-biofunctionalized AgNPs' compared with SPSp on lymphocytes collected from TB patient infected with diverse mycobacterial strains. For *in vitro* analysis using cell models peripheral blood lymphocytes were collected from 78 pulmonary TB patients: 45 infected with multidrug-resistant strains (including 22 cases infected before the onset of the treatment and 23 cases which acquired drug-resistance during the anti-TB treatment) and 33 with drug-susceptible strains. Immunomodulatory activity was measured via phytohemagglutinin-induced blast transformation test and immune modulation index. Pro- and anti-inflammatory activity was assessed through IFN- γ , IL-4 and IL-10 concentration in the supernatant. Results: statistical analysis confirmed that *Spirulina-derived polysaccharides* decreased IFN- γ release, whereas biofunctionalized AgNPs enhanced its production. Both active biological agents increased anti-inflammatory cytokines (IL-4 and IL-10), with a more pronounced effect observed following administration of *Spirulina-derived polysaccharides*. Among tested groups, lymphocytes from patients with drug-susceptible TB exhibited the strongest response, followed by those with primary drug-resistance, while from patients with acquired MDR-TB showed the weakest reaction. These findings suggested that both *Spirulina-derived polysaccharides* and AgNPs biofunctionalized with these polysaccharides can be used as immunostimulatory therapies, due to their dual pro- and anti-inflammatory effects and the potential to restore immune balance.

S1-P12 (805) Influence of Surface Pre-treatment and Thermal Annealing on the Electrochemical and Wettability Behavior of Copper

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This study investigates how different surface pre-treatments — acid etching, argon plasma exposure, and gold sputtering — combined with thermal annealing affect the wettability and electrochemical behavior of high-purity copper. Contact angle measurements showed a clear transition from hydrophobic copper (97°) to highly hydrophilic surfaces (down to 7.1°) after oxidation. Plasma-treated surfaces showed variable wettability depending on treatment time and gas flow, ranging from hydrophobic to moderately hydrophilic. Cyclic voltammetry and electrochemical impedance spectroscopy confirmed that these surface modifications changed redox activity and charge transfer resistance, mainly due to altered surface oxide structure and energy levels. Thermal annealing further influenced the oxide growth, making it more uniform and stable, which in turn affected the electrochemical response. Such thermal treatment after surface modification helped to stabilize the oxide layer and tune its electronic properties. These combined effects suggest that a proper sequence of surface pre-treatment and annealing can be used to control the copper surface for better performance in electrochemical systems. This may be useful for applications in sensing, catalysis, or corrosion protection, where both wetting properties and electrochemical stability are critical. The results highlight the importance of understanding how surface oxide properties, wettability, and charge transfer processes are linked, and how they can be engineered in a controlled way. Further work is needed to study the long-term durability and repeatability of these modified copper surfaces under practical conditions.

S1-P13 (822) XRD and XPS Investigation of CeO₂, Yb₂O₃, and Their Composite Oxide Nanostructures

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In this study, we report the synthesis and comprehensive characterization of pure Yb₂O₃, pure CeO₂, and mixed Yb₂O₃:CeO₂ nanoparticles with varying molar ratios, prepared via a simple sol-gel method followed by thermal treatment. Structural analysis by X-ray diffraction (XRD) confirmed the formation of cubic crystalline phases for all samples, with crystallite sizes ranging from 24.5 nm for pure Yb₂O₃ to 5.1 nm for the 1.0Yb₂O₃:0.5CeO₂ composition, indicating that Ce incorporation leads to significant crystallite size reduction. The addition of CeO₂ induced lattice strain and increased dislocation density, reflecting the presence of structural distortions and enhanced defect formation, which suggest the successful incorporation of Ce ions into the Yb₂O₃ matrix and the formation of solid solutions. X-ray photoelectron spectroscopy (XPS) analysis confirmed the chemical composition and oxidation states of the constituent elements. The O 1s spectra revealed contributions from lattice oxygen and oxygen vacancies, indicating defect-related features that may influence the electronic properties. The Ce 3d spectra displayed a dominant Ce⁴⁺ component with the presence of Ce³⁺ species, implying partial reduction, redox activity, and the potential for oxygen storage or catalytic applications. Yb 4d spectra confirmed the presence of Yb³⁺ without evidence of Yb²⁺ species. The experimental atomic ratios closely matched the theoretical stoichiometries, validating the compositional homogeneity and stability of the synthesized nanomaterials. Overall, the synthesized Yb₂O₃:CeO₂ nanomaterials exhibit tunable structural, electronic, and defect properties, making them promising candidates for applications in catalysis, gas sensing, and energy-related devices, where defect engineering and redox activity are critical for enhancing performance.

S1-P14 (762) Conductometric Sensor for Monitoring the Concentration of NaCl in Aquatic Environment

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Water quality control is a critical task in environmental monitoring, industry, and medicine. This paper presents the development of a conductometric sensor designed to monitor NaCl concentration in aqueous media. The design of the sensor cell and the electrochemical principles underlying the measurements are discussed. A mathematical model is proposed that accounts for temperature effects, ion types, and the geometric dimensions of the sensor. The impact of alternating current on measurement accuracy is analyzed, along with temperature compensation methods utilizing thermistors. An improved approach to exciting active conductometric sensors is introduced, enabling accurate monitoring of ionic impurities. The AC excitation method, based on rectangular signals with cyclic polarity reversal, effectively suppresses constant errors, noise, and parasitic thermocouple voltages. This technique ensures high accuracy by minimizing radio frequency interference and thermal self-heating of the sensor. A functional diagram based on a bridge configuration is provided, detailing the operation of a transistor switch stage used to generate a symmetrical excitation signal. The advantages of AC over DC excitation are substantiated, particularly in terms of thermal stability, sensitivity, and measurement reliability. The developed sensor circuit enables precise determination of dissolved substance concentrations and avoids systematic errors associated with electrolysis under direct current. Calibration was performed using standard solutions, and the sensor's metrological characteristics—including absolute, relative, and total measurement errors—were evaluated. The results confirm the high accuracy of the proposed system for water quality monitoring.

S1-P15 (814) Decontamination of Soil Polluted with DDTs and HCH by Nano Zerovalent Iron

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Nano zerovalent iron, encapsulated in poly-*N*-vinylpyrrolidone (nZVI/PVP) was used for the decontamination of soil long-term polluted with persistent organic pollutants, organochlorine pesticides: DDTs (dichlorodiphenyltrichloroethane and its metabolites) – 4.2 mg/kg dry soil, HCHs (isomers of hexachlorocyclohexane) – 1.2 mg/kg dry soil. The experiment was established *ex situ* and it was designed in oxic and cycled anoxic/oxic conditions. HCHs, mostly represented by the persistent *beta*-HCH isomer, disappeared completely after the first cycle of soil remediation. The concentration of DDTs decreased by 14 times, mostly due to transformation of *p,p'*-DDT isomer, in the soil amended with nZVI/PVP nanoparticles. By the end of the third cycle of soil remediation, the concentration of *p,p'*-DDT amounted to only 4-6% of the initial concentration. The transformation of DDT took place both in aerobic and anaerobic pathways, with the formation of DDE and DDD metabolites correspondingly. Analysis of soil microbiome involved in nitrogen transformation processes demonstrated that, in soil supplemented with nZVI/PVP and soy extract, the number of ammonifying bacteria has increased, resulting in a population that was more than 4.5 times higher, compared to soil without amendments. The additives did not affect the growth of oligotrophic bacteria and bacteria assimilating mineral forms of nitrogen, and the application of soy extract to the soil restored the number of micromycetes, suppressed under the anoxic conditions. This integrated approach offering a solution for remediating soils contaminated with highly persistent organochlorine pesticides.

S1-P16 (834) Comparative Photoluminescence Study of Nitrogen- and Oxygen-Doped Carbon Dots Synthesized by Distinct Routes

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Carbon dots (CDs) represent a category of luminescent nanomaterials that are attracting significant interest because of their adjustable photophysical characteristics, biocompatibility, and potential applications in sensing, imaging, and optoelectronics.

This study presents a comparative investigation of two types of carbon dots synthesized through distinct molecular precursors and fabrication techniques. Nitrogen-doped carbon dots were synthesized through the pyrolysis of N-hydroxyphthalimide, whereas oxygen-doped carbon dots were produced hydrothermally using α -ketoglutaric acid. The samples exhibit variations in heteroatom content, particle size, and surface chemistry, attributable to the different synthesis methods used. Characterization through UV-Vis spectroscopy, photoluminescence (PL) spectroscopy, Fourier-transform infrared spectroscopy (FTIR), and X-ray photoelectron spectroscopy (XPS) demonstrated significant variations in optical behavior. The N-doped carbon dots displayed broader emission bands and a stronger dependence on excitation, whereas the O-doped carbon dots exhibited narrower, blue-shifted emission characteristics. The observed variations result from differences in surface functional groups, the degree of graphitization, and modifications to the electronic structure caused by dopants and synthesis conditions.

While a direct one-to-one comparison is constrained by methodological differences, our findings offer significant insights into the combined effects of precursor chemistry and fabrication route on the fluorescence properties of CDs. This underscores the importance of a comprehensive design strategy in the development of CDs for specific functionalities, especially in applications requiring precise control over emission characteristics.

This research enhances the comprehension of structure-property relationships in carbon-based nanomaterials and provides insights for optimizing their properties via controlled synthesis methods.

Acknowledgements: The authors are thankful for the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2022-I8-291, contract no. 760081/23.05.2023, within the National Recovery and Resilience Plan.

S1-P17 (836) Preparation of Dextran–Guanosine–Gold Hybrid Magnetic Nanoparticles as Substrates for Surface-Enhanced Raman Scattering

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Magnetic nanoparticles have attracted significant attention in recent years due to their unique magnetic properties, biocompatibility, and versatility in biomedical and sensing applications. The integration of magnetic nanoparticles with noble metals such as gold further enhances their functionality, enabling their use in plasmonic and surface-enhanced Raman scattering (SERS) platforms.

Hybrid magnetic nanoparticles were synthesized by coating magnetite (Fe_3O_4) cores with dextran, followed by functionalization with guanosine and benzene-1,4-diboronic acid in the

presence of LiOH as base. Equimolar amounts of guanosine and benzene-1,4-diboronic acid were used to promote the formation of boronate ester linkages both with guanosine and the dextran shell. Subsequent addition of HAuCl_4 and NaOH led to the spontaneous formation of gold nanoparticle shell, resulting in a black coloration of the solution, indicating the formation of gold aggregates.

The resulting hybrid materials were characterized by dynamic light scattering (DLS) for hydrodynamic size and colloidal stability, scanning electron microscopy (SEM) and scanning transmission electron microscopy (STEM) for morphological analysis, X-ray diffraction (XRD) for structural characterization, and UV-Vis spectroscopy to confirm the presence of gold and assess optical properties.

The preliminary investigations on the SERS enhancement properties, tested using methylene blue as a Raman reporter molecule, suggests they could be promising candidates for SERS-based detection methods.

This work was financially supported by a grant from the National Research Authority, project no. PNRR-III-C9-2023-I8-161, MultiPodGaN, contract no. 760285/27.03.2024, within the National Recovery and Resilience Plan.

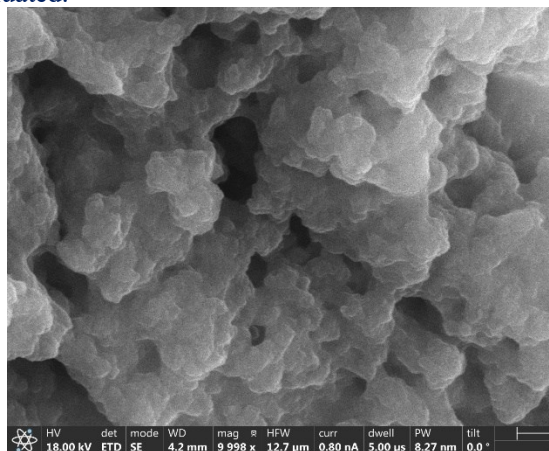
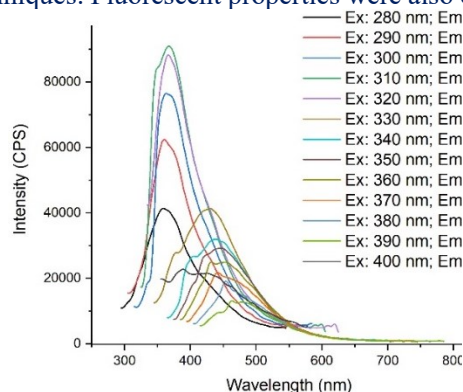
S1-P18 (838) New Lignin-based Carbon Structures

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Carbon materials have potential in energy and environmental applications due to their chemical and mechanical stability, high specific surface area, relatively high conductivity and porous structure. The interest for lignin valorization is highly increased due to the need for sustainable materials and reducing reliance on fossil fuels. The lignin resistance to depolymerization represents a major challenge in its processing to obtain value-added products. Herein, a new carbon structure from LignoBoost lignin was synthesized and characterized using FTIR, DLS, XRD and STEM techniques. Fluorescent properties were also evaluated.



Fluorescence emission spectra of synthesized material

SEM image of lignin-based carbon structure

Table 1. Fluorescence lifetime decay curve fitting parameters

NanoLED source wavelength (nm)	Sample	τ_1 (ns)	a_1	f_1	τ_2 (ns)	a_2	f_2	τ_3 (ns)	a_3	f_3	χ^2	$\langle\tau\rangle$ (ns)
295	Em 368 nm	2.34	0.38	0.14	4.68	0.07	0.05	9.37	0.53	0.80	1.20	8.11
371	Em 452 nm	2.73	0.48	0.25	5.48	0.26	0.28	10.09	0.24	0.47	1.25	6.95

Our results evidenced that synthesized material exhibited excitation-dependent fluorescence emission behavior which probably arise from the complex structure of lignin. DLS evidenced particles of various sizes, while the zeta potential presented negative value due to the charge from the hydroxyl and carboxyl groups present on the material surface.

Funding: The authors are thankful for the financial support from the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2022-18-291, contract no. 760081/23.05.2023, within the National Recovery and Resilience Plan.

S1-P19 (812) GaAs Nanowire Architectures and Their Transformation into Oxide Networks

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Gallium arsenide (GaAs) is a well-known III-V semiconductor material, of interest for nanostructuring due to its electrical and optical properties. Its direct bandgap, high electron mobility, and ability to form stable nanostructures make it particularly suitable for applications in photonics, optoelectronics, and sensing. Recent research has focused on developing scalable methods to control its morphology at the nanoscale. In this work, we report the electrochemical fabrication of GaAs nanowires array based on the formation of porous domains. By integrating photolithography prior to electrochemical etching, selective formation of GaAs nanowires was achieved exclusively in the exposed regions, while pore nucleation under the photoresist was effectively suppressed. The morphology of the nanowires can be controlled by adjusting the electrochemical parameters. Smooth-walled nanowires array can be obtained under specific conditions, while perforated and wall-modulated nanowires form when crystallographic pores intersect at higher applied anodization potential. This behavior is characteristic for GaAs, where pore growth follows crystallographic directions.

Beside this, a thermal oxidation process was developed to transform the GaAs nanowire networks into gallium oxide (Ga_2O_3), preserving the original geometry and the GaAs substrate. This transformation enables the integration of semiconductor and oxide phases in a single platform and opens new possibilities for using GaAs-derived nanostructures in various fields.

As a result, the combined approach of the electrochemical nanostructuring followed by controlled oxidation demonstrates a reliable method for obtaining complex nanowire architectures with controlled morphology and composition.

S1-P20 (800) Method for Studying of Deformed Metallic Wires in Perpendicular Magnetic Field

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An experimental cell design have been developed for studying of the properties of anisotropic monocrystalline materials under the influence of magnetic field in the process of deformation. Investigation of the properties of low-dimensional objects under the influence of deformation is of interest and the most suitable objects are wires and whiskers since they have a large range of elastic deformation. Measurements of the dependences of the resistance on deformation of Bismuth wires in a transverse magnetic field were performed by modifying the design of the bronze cantilever of the insert, in which microwire is fixed. The proposed method provides the possibility of determining changes in the internal structure of deformed microwires according to the behavior of magnetoresistance and was applied to reconstruct the topology of Fermi surface in monocrystalline Bi wires under deformation by investigating quantum oscillations of magnetoresistance for deferent crystallographic orientations. Using the simultaneous action of uniaxial deformation and magnetic field, it is possible to select microwires from different metals, which can be used as primary elements with high sensitivity to different orientation of magnetic field.

S1-P21 (847) Photoluminescence Spectra Related to Local Site Symmetry in Eu(III) Coordination Compounds

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Eu(III) coordination compounds are being explored for their potential in medicine, particularly in anticancer therapies and as imaging agents. Eu(III) complexes also appear as desirable materials because of their excellent properties for various research applications as a spectroscopic probe [1]. Commonly under the UV excitation an Eu^{3+} complex exhibit a bright-red luminescence with narrow atomic-like emission bands. Because of relatively small number of components in the PL emission spectrum the Eu(III) ion represents a convenient research tool for deriving information on the symmetry properties of the specific complex. In this report we examine various aspects for interpretation of PL spectra related to local symmetry around Eu(III) ion, with the reference to our previous reported data on $[\text{Eu}_2(\text{o-MBA})_6(\text{phen})_2]$ and $[\text{Eu}(\mu_2\text{-OC}_2\text{H}_5)(\text{btfa})(\text{NO}_3)(\text{phen})]_2\text{phen}$ complexes.

The PL spectrum of an Eu(III) complex and the character of transitions splitting $^5\text{D}_{0,1} \rightarrow ^7\text{F}_J$ ($J=0-4$) appear as a “fingerprint”, that provide valuable hints on local symmetry around the Eu^{3+} ion. As very informative appears $^5\text{D}_0 \rightarrow ^7\text{F}_0$ transition between two non-degenerate levels. Registration of different components in this transition indicates on different emission sites of the complex. Complementary information is provided by the magnetic-dipole transition $^5\text{D}_0 \rightarrow ^7\text{F}_1$ as well as the electric-dipole hypersensitive transition $^5\text{D}_0 \rightarrow ^7\text{F}_2$. Actually, the final assignment of the point group symmetry should be made on the basis of single-crystal XRD measurements.

S1-P22 (807) Emerging Hybrid Aero-nanomaterials Based on Wide-band-gap Semiconductor Compounds

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This work presents significant advancements in ultraporous three-dimensional nano-architectures composed of carbon and wide-band-gap semiconductor compounds. These aero-nanomaterials, which combine the key properties of aerogels (ultra-low density, high porosity, superior insulation) with nanoscale enhancements, exhibit broadened functionality and applicative potential. The study delves into the intricate synthesis methods, detailed characterization techniques, and varied applications of carbon-based aeromaterials. Particular attention is given to cutting-edge developments such as graphene aerogels and Aerographite, highlighting their unique structural and functional properties. Functionalizing Aerographite and graphene aerogels with strategically chosen semiconductors like GaN and ZnO results in composite materials exhibiting exceptional promise for applications in electronics, photonics, and environmental remediation, addressing critical challenges in these areas. Examining the mechanical, electrical, and optoelectronic properties reveals their potential to revolutionize environmental science, biomedical engineering, and next-generation electronics. A key highlight is the development and application of aerogalnite or aero-GaN, a semiconductor-based aeromaterial with exceptional properties like ultra-low density, mechanical flexibility, and can be used for effectively shield electromagnetic radiation in a wide range of frequencies. Aero-GaN's unique hydrophilic-hydrophobic behavior facilitates self-assembling structures for applications such as pressure sensors and microfluidic devices.

The continued development of other semiconductor-based aeromaterials, including Aero-Ga₂O₃, Aero-TiO₂, and Aero-ZnS, further expands opportunities for creating multifunctional materials optimized for technological and industrial applications.

S1-P23 (833) Optical Properties and *in vitro* Fluorescence Imaging of Nitrogen-doped Carbon Dots

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Carbon dots (CDs) are versatile nanomaterials known for their biocompatibility, tunable fluorescence, and easy chemical modification. These zero-dimensional carbon nanomaterials, with diameters generally under 10 nanometers, have garnered considerable interest for their independent applications across various fields, including biomedical imaging. Their remarkable properties and adaptability are driving innovation in numerous areas, positioning these carbon nanostructures at the forefront of advanced materials research and technological advancement.

In this study, four nitrogen-doped carbon dots (N-CDs) were synthesized from the same precursor by varying the duration of thermal processing. By exploring different calcination times, aimed to understand and to evaluate the impact of thermal processing on the structural and functional properties of these low-dimensional carbon nanomaterials. Increasing the treatment time generally improved the graphitic nature of the carbon nanostructures, while maintaining nitrogen functionalities and increasing surface oxidation. These changes in the surface chemistry had important implications for the fluorescence properties. Their optical properties were thoroughly characterized using ultraviolet-visible (UV-Vis) absorption and fluorescence spectroscopies. These techniques provided detailed insights into their absorption behaviour, emission and excitation profiles, Stokes shifts, fluorescence intensity, quantum yields and lifetimes, which are important parameters for their performance in imaging applications. Synchronous fluorescence spectroscopy (SFS) indicated the existence of several emissive species in the samples. The N-CDs fluorescence imaging capability was assessed in both aqueous solutions and biological environments using human gingival fibroblast (HGF) cells.

This integrated approach allowed us to correlate the effects of thermal processing conditions with the functional imaging performance of the carbon dots, thereby identifying the optimal synthesis parameters for enhanced fluorescence-based biomedical applications.

Acknowledgements: The authors are thankful for the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2022-I8-291, contract no. 760081/23.05.2023, within the National Recovery and Resilience Plan.

SECTION S2

Biomaterials and devices for medical applications

S2-1.1 (678) Role of Copper-Thiosemicarbazone Coordination Compounds in Modulating Lipid Peroxidation Indices: an *in Vitro* Evaluation

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Medicinal chemistry is strongly focused on discovering new antitumor agents that are both more effective and less toxic. Thiosemicarbazones and their metal complexes have demonstrated properties suitable for a variety of applications, making these molecules attractive for further evaluation as potential new therapeutic agents in cancer treatment. The administration of new heterocyclic Schiff bases and their copper complexes with thiosemicarbazones exerts varied influences on lipid peroxidation indices in the supernatant. The general objective of this study was to investigate the effects of nine copper coordination compounds with thiosemicarbazones (CCT) and doxorubicin, compared to controls, on lipid peroxidation markers via an *in vitro* experiment. A series of *in vitro* experiments was performed on peripheral blood samples collected from 10 apparently healthy individuals. All samples were tested in duplicate. The results showed that, depending on their chemical structure and concentration, these compounds exert a selective action on lipid peroxidation markers. In this study, changes in advanced protein oxidation products and reactive oxygen metabolites were statistically inconclusive with regard to lipid peroxidation processes, as the prooxidant–antioxidant balance became more pronounced in order to reduce reactive oxygen and nitrogen species. The influence of the studied preparations on lipid peroxidation demonstrated differing effects on malondialdehyde (MDA) levels: at a concentration of 10 $\mu\text{M/L}$, a prooxidant increase was observed, whereas at 1 $\mu\text{M/L}$, MDA levels decreased, indicating enhanced antioxidant activity.

S2-1.2 (710) In Silico Profiling of Natural Bioactive Multitarget Compounds: Implications for Modulation of Inhibitory Neurotransmission

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Herbal medicines and supplements exhibit the phenomenon of neurohormesis, mechanisms that may prevent or mitigate neurodegenerative pathogenesis. Gephyrin's role in the stabilization of receptors for inhibitory transmitters and regulation in postsynaptic activity makes it an important target for research and possible therapeutic approaches. The impairment of gephyrin function will also lead to cognitive impairment, which is a key symptom of Alzheimer's disease. Phosphorylation of gephyrin by glycogen synthase kinase -3 β is important for neuronal synaptic plasticity in modulating GABAergic transmission. This work aims to evaluate the potential of the interaction of artemisinins, curcumin, and flavonoids with the scaffolding protein gephyrin, the kinase GSK-3 β , using molecular modeling methods. All studied compounds interact with targets with high affinity. Amino acid residues Asp327, Phe330, which are important for the interaction of gephyrin and artemisinins, are identical to those that mediate the interaction of gephyrin and the inhibitory mediator receptors. Therefore, modulation of interaction with receptors may be a promising strategy for drug development and pharmacological therapy of AD. Many of the amino acid residues of gephyrin that mediate interactions with receptors are located in the C-terminal E domain. Docking of all compounds revealed interaction in the ATP-binding site of GSK-3 β with high affinity. Of all ligands, only DDHA displays a hydrophobic contact with Phe93 in the substrate-binding site, which is typical for inhibitors of peptide nature. Thus, the studied bioactive compounds exhibit multitarget neuroprotective action, cross the BBB, and may be considered as potential candidates for the treatment and prevention of AD.

S2-1.3 (715) Modulating Phenolic Compounds Synthesis and Antioxidant Activity in *Dunaliella salina* Microalgae by Metal Oxide Nanoparticles under Variable Salinity Conditions

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The increasing use of metal oxide nanoparticles (NPs) in various applications raises concerns about their ecological impact, but also offers opportunities for targeted modulation of microalgal metabolism. This study evaluates the effects of titanium dioxide (TiO₂), zinc oxide (ZnO), and copper oxide (CuO) nanoparticles on the phenolic content and antioxidant activity of the green microalga *Dunaliella salina*, cultivated in mineral media under two salinity conditions (60 g/L and 120 g/L NaCl). The microalgal culture was exposed to NPs at concentrations ranging from 0.1 to 30 mg/L. Total phenolic content was quantified in aqueous extracts, while antioxidant activity was measured using the ABTS assay in ethanolic extracts.

The results demonstrated that nanoparticle type, concentration, and salinity level interactively influenced the biosynthesis of phenolic compounds and the antioxidant potential of the biomass. Low NP concentrations (0.1–1 mg/L), particularly under moderate salinity (60 g/L NaCl), stimulated phenolic accumulation, with CuONPs showing the most consistent and pronounced effect. In contrast, higher concentrations of TiO₂ and ZnO, especially under high salinity (120 g/L NaCl), led to a significant decrease in phenolic levels. Antioxidant activity followed similar trends, being enhanced by low to moderate levels of CuONPs and ZnONPs, particularly under high salinity, but was suppressed at higher NP doses, likely due to excessive oxidative stress.

These findings highlight the potential of controlled nanoparticle application to enhance the biosynthesis of valuable antioxidant compounds in *Dunaliella salina*.

S2-1.4 (737) Antitumor Potential of Biogenic Iron Oxide (Fe₃O₄) and Silver Nanoparticles, as well as Complex with 5-Fluorouracil, Against the ZR-75 Human Breast Carcinoma Cell Line

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Due to their distinctive features—such as selective action and the ability to enable targeted drug delivery—nanoparticles (NPs) offer promising opportunities to enhance the effectiveness of diagnostics and therapies for a wide range of diseases, especially cancer. Numerous studies on the biological properties of silver nanoparticles (AgNPs) and iron oxide nanoparticles (IONPs) highlight their potential for biomedical applications that require a high degree of biocompatibility. Moreover, the use of green synthesis methods, resulting in the formation of biocompatible biogenic nanoparticles, further expands the scope of their research. The aim of this study was to perform a comparative evaluation of the anticancer potential of biogenic silver and iron oxide nanoparticles relative to an established anticancer drug, using the breast carcinoma cell line ZR-75 (ATCC).

The results of the study revealed that biogenic Fe₃O₄ nanoparticles exhibited no cytotoxicity, demonstrating high biocompatibility and potential as drug delivery carriers. In contrast, AgNPs showed a pronounced dose-dependent antitumor effect (IC₅₀ – 2.6 µg/well), which was not attributed to the action of the stabilizing agent *Ocimum araratum*. When combined with the anticancer drug, the complex exhibited an IC₅₀ of 5.3 µg/well. AgNPs appear to be promising agents for further investigation of their antitumor activity profile and mechanisms of action, while Fe₃O₄ nanoparticles, due to their absolute biocompatibility, can be explored as potential drug delivery systems.

S2-1.5 (746) Biogenic Iron Oxide and Platinum Nanoparticles: Characterization and Biological Activity

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Nanotechnology has emerged as a transformative force in modern medicine, enabling the development of innovative diagnostic and therapeutic agents. In this study, we report the biogenic synthesis and characterization of iron oxide (Fe), platinum (Pt), and composite Fe/Pt nanoparticles (NPs) using an aqueous extract of *Ocimum araratum*. The extract demonstrated high antiradical activity ($IC_{50} = 0.39 \pm 0.09$ mg/mL) and sufficient flavonoid content, facilitating the reduction and stabilization of metal ions during nanoparticle formation. The synthesized nanoparticles exhibited average hydrated sizes ranging from 417 to 490 nm, with the smallest dimensions recorded for Fe/Pt composites.

The cytotoxic potential of the nanoparticles was evaluated *in vitro* using the A549 (ATCC CCL-185) lung carcinoma cell line via MTT assay. While Fe NPs exhibited moderate cytotoxicity at higher concentrations ($IC_{50} = 0.38$ mg/mL, or 0.95 μ g/well), Pt and Fe/Pt nanoparticles demonstrated lower, dose-dependent cytotoxicity, indicating a more favorable safety profile. Notably, none of the synthesized nanoparticles displayed antibacterial activity against *Escherichia coli* K-12, suggesting specificity toward cancer cells rather than microbial targets.

These findings underscore the advantages of using plant-based, environmentally friendly synthesis approaches to produce biocompatible nanoparticles with potential theranostic applications. The integration of Pt with Fe in a single nanocomposite offers both therapeutic and diagnostic functionalities, aligning with the goals of personalized medicine. Overall, the study supports the potential of Fe/Pt nanocomposites as multifunctional nanomaterials for future biomedical applications, particularly in targeted cancer therapy and diagnostics.

S2-1.6 (817) Translocation of Nano-Gold, -Silver and -Copper in *Calendula officinalis* L. Tissues under Foliar Exposure

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Nanosized materials contribute significantly to modern industry and agriculture, with both beneficial and potentially adverse effects on plant systems. This study investigated the capacity of *Calendula officinalis* L. to accumulate and translocate gold (AuNPs), silver (AgNPs), and copper (CuNPs) nanoparticles applied by foliar spraying over a 28-day period, at concentrations ranging from 1 to 100 mg/L. Metal accumulation in plant tissues and soil was quantified using atomic absorption and optical emission spectrometry. The highest accumulation occurred for gold nanoparticles, reaching up to 143 mg/kg in leaves and 94 mg/kg in stems. In comparison, copper and silver levels in plant tissues remained below 50 mg/kg. Notably, CuNP treatments led to a concentration-dependent decrease in copper content in both roots and soil, while AuNPs and AgNPs increased their respective concentrations in these compartments—likely due to interactions with root exudates affecting rhizosphere dynamics.

Physiological responses of calendula leaves varied depending on nanoparticle type and dose. Low concentrations (1–10 mg/L) generally stimulated or maintained photosynthetic pigment levels, antioxidant activity, and phenolic compound content. However, higher concentrations (50–100 mg/L) tended to inhibit pigment accumulation and modify antioxidant and phenolic profiles. Gold and silver NPs mostly enhanced antioxidant activity, whereas copper NPs induced a more variable response depending on dosage. These findings highlight the complex interplay between nanoparticle characteristics and plant physiology, and underline the necessity of precise dosage control when considering the application of metal nanoparticles in agricultural contexts.

S2-1.7 (835) Assembly and Stability of Trastuzumab-Conjugated and Unmodified poly(L-histidine)-poly(Ethylene Glycol) Micelles for Targeting HER2-Positive Cells

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Micelles have emerged as promising nanocarriers in biomedical research, offering a versatile platform for targeted drug delivery. In this study, we designed and investigated a poly(L-histidine)-poly(ethylene glycol) (PHis-PEG) micelle system capable of incorporating a fluorophore tag within its core through covalent binding, while simultaneously facilitating the surface attachment of the monoclonal antibody trastuzumab. Our investigation highlighted the critical aspect of micelle stability, particularly at concentrations below the critical micelle concentration (CMC), essential for ensuring efficacy in in vivo applications. We observed that covalent or physical loading of hydrophobic molecules into the micelle core enhances stability below the CMC, albeit with destabilization upon trastuzumab conjugation at investigated concentrations. Furthermore, stability studies conducted in the presence of bovine serum albumin, simulating the protein-rich environment of blood, provided insights into the behaviour of PHis-PEG micelles under physiological conditions. Our findings revealed the time-based stability of unmodified micelles versus trastuzumab-functionalized micelles loaded with hydrophobic molecules, underlining their potential for targeted drug delivery. Additionally, functional efficacy assessment post-covalent conjugation of trastuzumab in comparison to free trastuzumab demonstrated substantial efficacy against two HER2 receptor-overexpressing cell lines, highlighting the clinical relevance of our developed PHis-PEG micelle system in targeted cancer therapy. This study elucidates the advantages and limitations of PHis-PEG micelles, emphasizing their potential as pH-responsive targeted carriers and advancing the understanding of stimuli-responsive cancer drug delivery systems.

Acknowledgements

This work was financially supported by a grant from the National Research Authority, project no. PNRR-III-C9-2023-I8-161, MultiPodGaN, contract no. 760285/27.03.2024, within the National Recovery and Resilience Plan.

S2-1.8 (837) Supramolecular G4 Hydrogel Systems for Cell Support and Antimicrobial Applications

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Supramolecular hydrogels, assembled from low-molecular-weight building block gelators, have attracted significant attention for biomedical applications, including targeted drug delivery, regenerative medicine, and 3D cell culture platforms. Among these, guanosine-based hydrogels are particularly promising due to their formation through self-assembly of guanosine quartets (G4) triggered by specific metal ions. In this study, we explored the synthesis and biomedical applicability of dynamic hydrogels formed from guanosine and benzene-1,4-diboronic acid, employing various templating cations (K^+ , Ba^{2+} , Mg^{2+}). By altering the metal ions within the hydrogel structure, we achieved precise control over the swelling behavior and water retention capabilities, crucial factors enhancing their biocompatibility. Furthermore, we successfully integrated nanomaterials, such as single-walled carbon nanotubes and graphene oxide, significantly enhancing the mechanical and functional properties of the hydrogels. To further broaden their applicability, cyclodextrin molecules were incorporated into the G4 hydrogel network, enabling effective antimicrobial activity. Our findings demonstrate the versatility and tunability of G4-based supramolecular hydrogels, highlighting their considerable potential as multifunctional biomaterials for advanced medical applications.

This work was financially supported by a grant from the National Research Authority, project no. PNRR-III-C9-2023-I8-161, MultiPodGaN, contract no. 760285/27.03.2024, within the National Recovery and Resilience Plan.

S2-P24 (788) Modification of Antimicrobial, Antioxidant and Catalase Activities in Cell Free Supernatant of Some Bacillus Strains Induced by Iron Oxide Nanoparticles

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Iron oxide nanoparticles (Fe_3O_4) are extensively studied for their interactions with microorganisms, and they have promising applications in biotechnology and medicine. *Bacillus* spp. can synthesize a variety of structurally and functionally diverse secondary metabolites, including antibiotic peptides such as gramicidins, bacitracins and tyrocidines, which exhibit strong antimicrobial activity. It was investigated the effects of iron (II, III) oxide nanoparticles on the antimicrobial, antioxidant, and catalase activities of the cell-free supernatant obtained from the cultivation of some *Bacillus* strains. Rising nanoparticle concentrations up to 10.0 mg/L increased antimicrobial activity, which was strain-dependent. In most cases, a concentration of 10.0 mg/L exhibited a greater antimicrobial effect, with increases ranging from 17% to 36% compared to the control. The presence of iron oxide nanoparticles decreased the protein content of the cell-free supernatant, accompanied by a significant increase in catalase activity, that revealing a strong correlation with a coefficient of determination $R^2 = 0.943$. Antioxidant activity, assessed via the ABTS assay, showed lower values than the control, indicating an inhibitory effect of the nanoparticles on this parameter. The results highlight the potential of iron oxide nanoparticles to modulate microbial metabolism by stimulating antimicrobial activity and optimize the production of bioactive compounds, underscoring their potential for applications in microbial biotechnology.

S2-P25 (840) New Ionic Liquids Based on Benzimidazole Cation: Synthesis, Characterization and Antibacterial Activity

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Ionic liquids (ILs) are defined as a class of organic salts with the melting point below 100 °C [1]. This class of compounds has gained significant interest due to their intrinsic properties, such as a negligible vapor pressure, wide electrochemical window, thermal stability and structural tunability, properties that endorse ionic liquids for diverse applications in a multitude of chemical and industrial fields. [2]

This work presents the synthesis and characterization of a new series of ionic liquids based on substituted benzimidazole cations. Benzimidazole derivatives can possess anticancer activity [3], as such, a series of benzimidazolium salts have been synthesised through quaternization reactions of an iodophenyl substituted benzimidazole molecule. By systematically varying the alkyl chain length, steric hindrance, and electronic properties of the benzimidazole derivatives, the melting points, viscosities, and hydrophobicity profiles of the resulting ionic liquids can be adjusted.

The synthesized ionic liquids were characterized by NMR spectroscopy, Mass Spectrometry, FT-IR, TGA/DSC, and Single Crystal X-ray Diffraction. Selected molecules were also tested for antibacterial activity.

Furthermore, the structural diversity of the cations enables exploring correlations between molecular architecture and physicochemical behavior. These insights will guide future design strategies for task-specific ionic liquids. The versatility of the ionic liquids' properties, underscore their potential as next-generation materials for multiple technological fields.

Acknowledgement: This work was financially supported by a grant from the National Research Authority, project no. PNRR-III-C9-2023-I8-161, MultiPodGaN, contract no. 760285/27.03.2024, within the National Recovery and Resilience Plan.

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S2-P26 (736) A Comparative Analysis of the Antibacterial Properties of Biogenic Silver Nanoparticles and Their Antibiotic Complexes Against Sensitive and Resistant Strains of *Escherichia coli*

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The emergence and spread of multidrug resistance (MDR) among bacterial pathogens represent a major challenge in contemporary medicine, further aggravated by the limited availability of new, effective antimicrobial agents. This drives the active search for alternative therapeutic approaches, including the use of nanomaterials. Biogenic silver nanoparticles (AgNPs) have attracted attention as promising antimicrobial agents due to their ability to disrupt bacterial biofilms and mechanisms of intercellular communication (quorum sensing). However, their clinical application is still limited, partly due to the risk of bacteria developing resistance to the nanoparticles themselves. The aim of this study was to evaluate the antibacterial activity of biogenic AgNPs and their complexes with antibiotics – amikacin (AM), ceftriaxone (CF), and chloramphenicol (CHLF) – against the sensitive strain *Escherichia coli* DSM 1116 and the resistant strain *E. coli* K-O11 (ATCC 55124). The results showed that biogenic AgNPs enhance the activity of antibiotics against resistant bacteria. The CH+AgNPs complex exhibited antibacterial activity three times greater than that of the AgNPs alone against both *E. coli* strains. The AgNPs+AM complex was six times more effective than AgNPs and 1.5 times more effective than amikacin alone. The most pronounced synergistic effect was observed for the AgNPs+CF complex: its activity against *E. coli* K-O11 was 11 times higher compared to AgNPs and 7 times higher compared to ceftriaxone. These findings underscore the potential of biogenic silver nanoparticles as components of combined **therapeutic strategies** to improve treatment efficacy and combat multidrug resistance.

S2-P27 (841) Aero-Semiconductors and Carbon Nanodots: Nanostructured Solutions for Antibiotic Contamination Remediation and Cancer Theranostics

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The development of advanced nanostructured materials for environmental and biomedical applications represents a central challenge in nanotechnology. This work presents recent advancements in the design and application of innovative nanomaterials developed through the *MultiPodGaN* (contract no. 760285/27.03.2024, CF 161) and *IntelDots* (contract no. 760081/23.05.2023, CF 291) projects, targeting environmental remediation and biomedical imaging.

In the framework of *MultiPodGaN*, we designed and tested novel three-dimensional (3D) aeromaterials [1] derived from GaN [2], ZnO [2], and TiO₂ [3] microtetrapods. These ultra-porous, lightweight structures, further functionalized with noble metal nanodots, demonstrate outstanding photocatalytic efficiency for the degradation of tetracycline under UV and solar light, achieving removal rates above 90% within 120 minutes. These materials exhibit high surface area, chemical stability, and reusability, offering promising solutions for water purification and advanced filtration technologies [2,3].

Complementary, the *IntelDots* project focuses on nanomedicine platforms for oncology. We report the synthesis of carbon nanodots (CNDs), including Mn-doped, that act as dual-mode agents for fluorescence and magnetic resonance imaging (MRI) [4,5]. N- and O-functionalized carbon dots⁶ reveal excellent photostability, antioxidant activity, and biocompatibility, supporting their potential in fluorescence imaging and therapeutic applications. These nanomaterials exhibit strong photoluminescence, high photostability, and favorable relaxivity values surpassing some

commercial contrast agents. Biological evaluations demonstrate low cytotoxicity, antioxidant activity, and selective effects on tumor cell lines. Additionally, functional nanostructures such as Rhein-loaded liposomes [7] and antioxidant-modified chitosan nanofibers [8] were developed, demonstrating improved oral bioavailability, immunomodulation, and tissue regeneration potential.

These results illustrate that engineered nanostructures, whether semiconductor aero-architectures for environmental remediation or multifunctional carbon-based systems for oncology, can provide scalable, efficient, and sustainable solutions to societal challenges. The integration of materials science with biomedical engineering in these projects facilitates the advancement of nanotechnology towards real-world applications in health and environment.

Acknowledgements: The authors are thankful for the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2022-I8-291, contract no. 760081/23.05.2023, and project no. PNRR-III-C9-2023-I8-161, MultiPodGaN, contract no. 760285/27.03.2024, within the National Recovery and Resilience Plan.

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SECTION S3

Bioinstrumentation, signal and image processing

S3-1.1 (696) Method for Determining Carbonyl Proteins and their Derivatives and their Pathogenetic Importance

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Reactive oxygen species (ROS) are key mediators in a wide range of physiological and pathological processes, including aging and the development of chronic diseases. While excessive ROS levels can damage proteins, lipids, and DNA, controlled concentrations are essential for normal cellular signaling and homeostasis. This dual role of ROS has created a growing need for sensitive, reproducible, and cost-effective methods to monitor oxidative stress. In this study, we developed and optimized a spectrophotometric method for the quantification of carbonylated proteins (CP), which are established markers of oxidative protein damage. The method is based on the reaction of CP with 2,4-dinitrophenylhydrazine (2,4-DNPH), followed by absorbance measurement in a 96-well microplate format. This microplate-based approach enables simultaneous processing of a large number of samples, reduces reagent and sample consumption, and significantly increases throughput and efficiency. The optimized protocol demonstrated enhanced analytical performance, reduced cost per analysis, and shorter execution time compared to conventional assays. These characteristics make it well suited for both clinical diagnostics and basic research applications. Moreover, the method can be used to monitor oxidative stress in various pathological conditions and to assess the effectiveness of antioxidant therapies. Overall, the proposed approach offers a practical and scalable solution for studying protein oxidation and redox-related cellular dysfunctions.

S3-1.2 (700) Wearable Biosensors for Nutritional Monitoring of Soldiers: The Future of Prevention in Operational Theaters

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Wearable biosensors represent an advanced solution for physiological and metabolic monitoring under extreme operational conditions. This review aimed to comparatively analyze the functionality, technological characteristics, and applicability of wearable biosensors used for nutritional and physiological monitoring in military and high-performance contexts. A total of 26 scientific articles (2015–2025) indexed in the Web of Science – Core Collection were included based on defined eligibility criteria. Data extraction focused on monitored parameters, transduction technologies, biosensor type, application context, and study design. Each device was assessed using a functional scoring system evaluating portability, accuracy, and operational utility. The results revealed high average scores for portability and field applicability, especially among electrophysiological and optical biosensors. However, most devices focused on cardiovascular, respiratory, and thermoregulatory monitoring, with limited integration of nutrition-specific biomarkers such as glucose, lactate, or salivary analytes. Only a few systems provided truly multimodal tracking.

These findings emphasize a significant technological gap in the integration of comprehensive metabolic monitoring within wearable platforms. The analysis also highlights critical innovation

priorities: development of autonomous, multisensory biosensors; enhanced energy autonomy; and increased data fusion capacity.

In conclusion, wearable biosensors offer promising tools for strengthening physiological resilience, supporting preventive strategies, and improving real-time decision-making in military theaters. However, further innovation is needed to achieve robust, field-ready systems capable of holistic physiological and nutritional surveillance.

S3-1.3 (707) A Wireless Multi-Sensor Platform for Long-Term Human Gait Analysis

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Human gait assessment plays an essential role in clinical diagnostics, rehabilitation, and biomechanical research. While optical motion capture systems provide high spatial accuracy, their application is constrained by high cost, complex setup, and dependence on laboratory environments. Wearable inertial sensing offers a more accessible alternative, enabling real-world data collection in a portable and cost-effective manner.

This work presents a wireless sensor platform for the collection of biodynamic data from the lower limbs during walking. The platform consists of several compact sensor modules attached to the lateral surfaces of the thighs and shins, each independently recording accelerometer and gyroscope data and transmitting it via wireless connection to a mobile device.

To address the challenge of inter-sensor synchronization, a post-processing method is implemented. Each sensor operates on its own internal clock, resulting in unsynchronized timelines. The proposed approach defines a common time interval across all sensors and resamples each signal to a unified time grid using interpolation. This ensures precise temporal alignment without requiring hardware synchronization.

The resulting synchronized data can be used for calculating joint kinematics and further biomechanical analysis. The platform offers a flexible, low-cost solution suitable for various research and application contexts, including gait monitoring, functional assessment, and rehabilitation tracking.

S3-1.4 (723) Biomechanical Analysis of Bone-Implant Interaction in a Femoral Prosthetic Reconstruction

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This study presents a three-dimensional finite element analysis of a femoral bone-implant system designed for post-amputation prosthetic integration. The use of prostheses with implants that directly interact with the bone is currently a trend in modern biomedicine. In the development of such prostheses, preliminary modeling plays a huge role. The primary focus is on evaluating the effect of varying internal dry sliding friction coefficients, which characterize the evolving contact interaction between the implant and the bone during different stages of rehabilitation. A detailed 3D model of the human femur, the implant, and a segment of the prosthesis was developed, incorporating realistic anatomical geometry and material properties. The system was subjected to a simplified vertical loading condition, simulating the static weight-bearing scenario of an 80 kg patient in a standing posture. Simulations revealed a significant dependence of stress magnitudes and localization patterns on the friction coefficient at the bone-implant interface. The results provide insight into how micro-stiffness at the interface influences mechanical load distribution, especially critical during early postoperative stages when bone-implant fusion is incomplete. As the interface conditions evolve through the healing process, the biomechanical response of the system changes markedly. These findings offer valuable guidance for clinical rehabilitation protocols, informing load management strategies and improving long-term outcomes for patients undergoing limb prosthesis implantation.

S3-1.5 (777) Protocol Developing for Visual Function Testing Efficiency Increasing for Regular and Professional Drivers

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The paper presents the development of an innovative solution to increase the efficiency of the protocol for a correct and complete visual function testing protocol efficiency increasing among drivers. A non-conventional method has been accomplished, thus meaning two main steps: the first one invoked the programming and testing of a hardware interface for a complete and proper assisted testing, using a laptop or tablet device. The interface envisaged all necessary aspects in terms of visual testing: near and far acuity, response reaction, hand-eye coordination, vision in night conditions. The second step meant a device manufacturing in terms of optic, mechanic and hardware components for night conditions inducing in drivers. For this purpose a special lamp was realized, including several LEDs, commended by a hardware system, simulating different night condition while driving. An example could refer to simulate the appearance of a car coming from the opposite direction, having the meeting phase or the driving phase activated. The hardware system consisted in a developing board, the main component being an Arduino Uno programmed microcontroller. Finally the proposed method was tested due to several persons, having B and C driving license, and proved to be very efficient and useful one for the staff engaged for periodic medical control in drivers.

S3-1.6 (797) Design and Realization of a UV-C and Ozone-Based Device for Room Disinfection

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This paper focuses on the design and development of a UV-C (Ultraviolet-C) -based device intended for room disinfection. UV-C radiation, with wavelengths between 200-280nm, is well known for its germicidal properties, effectively inactivating bacteria, fungi, and viruses by disrupting their DNA and RNA. This paper aims to create a practical and efficient solution for reducing microbial contamination in enclosed spaces, particularly in the context of increased hygiene demands due to global health concerns. The device was built using commercially available UV-C lamps, an ozone generator, and an electronic control system for timed operation in the absence of direct human intervention. The device is intended to be a low-cost solution available to anyone who needs this solution. Some tests were conducted in order to see the efficacy of the device. This paper highlights the potential of UV-C technology as a non-chemical, environmentally friendly method for disinfection. Due to the impact of the COVID-19 pandemic, there are many users of this type of disinfection but also, it is intended to identify the situations in which this type of disinfection is not used appropriately, affecting either people around these systems or not being efficiently used. The final device can be adapted for various indoor environments such as hospitals, offices, classrooms, and homes.

S3-1.7 (843) Multi-scale, Multi-modal Correlative Characterization with Micrometer Accuracy for Material Science

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Introduction. Correlative characterization is the spatial registration of several imaging modalities aiming to combine complementary information on the same region of interest (ROI) [1]. The imaging modalities are supplemented by micro-structuring tools including focused-ion beam (FIB) technology for extraction of the ROI, and laser-milling for material removal.

Within the same length scale, combining several modalities on the same ROIs is well-established in electron microscopy, e.g. STEM imaging modalities (BF, DF, HAADF) with EELS and EDX spectroscopy, or the combination of APT and TEM. Across length-scales, the analysis of identical ROIs requires combination of different instruments. Without a correlative approach, the characterization of the full length-scale hierarchy relies on statistically random sample extracts, which only provides a good representation for very homogeneous samples, with similar ROIs uniformly distributed within the sample. However, for macroscopically inhomogeneous samples, such as heterogeneous catalysts, a correlative approach is indispensable to characterize the individual components of the sample. Therefore, for linking the local micro-structure to the macroscopic level of the sample, a full correlation of all applied techniques on the ROI is desired.

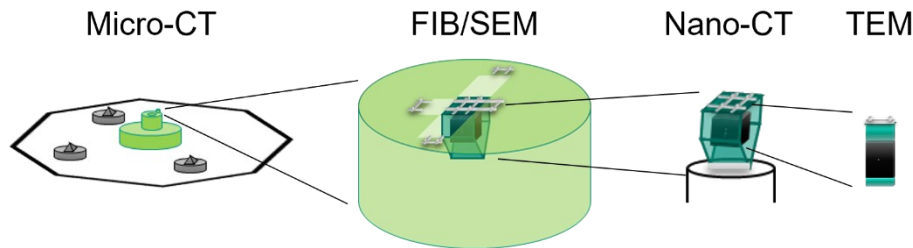
Objectives. We present a correlative workflow, which allows the combination of 3D analysis across several length scales from the bulk sample with defined laser pre-structuring for micro-CT at the sub-mm level, identification of regions of interest on the 10-100 μm scale in a FIB, for 2D/3D surface and tomography visualization by SEM/EDX/EBSD and light microscopy, followed by defined sample extraction and transfer to nano-CT and TEM.

Materials & methods. For this purpose, we developed a dedicated sample carrier, enabling large tilt angles for FIB work, and flexibility for direct transfer to micro-CT. The carrier is equipped with three-dimensional global reference markers for accurate determination of the rotation and tilt of the sample. Additionally, local markers, in the form of Pt-deposited or FIB-milled patterns, are placed

directly on the sample in the vicinity of the ROI. These facilitate accurate translational positioning around the ROI for FIB-extraction, after the rotation and tilt has been aligned using global markers.

Results. The workflow, using the correlative sample carrier, global and local markers, and a series of geometrical calculations, gave a two-fold result. Firstly, once the ROI position was located with a few μm accuracy, FIB projection images were generated for real-time overlap with the FIB image, guiding the FIB-extraction of the ROI for nano-CT and/or TEM. Secondly, an accurate image correlation in 3D was enabled, overlapping 3D tomographic and 2D projection images virtually in common image-processing software. We verified this workflow on samples from metallurgy [2] and catalysis [3].

Conclusion. Using global and local reference markers, and tracking them at different length scales, we achieved accurate ROI-targeting for FIB-extraction, and covering multiple length scales and imaging techniques. The workflow is aimed at routine multi-scale, multi-modal correlative investigations on samples from materials science, targeting specific ROIs, thereby gaining local chemical and structural information from bulk samples.



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S3-1.8 (799) Mechanical Ventilator Prototype with Self-disinfection and Ozone Therapy Function for Room Disinfection

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The role of this project is to improve the current mechanical ventilation systems and to increase the success rate of the medical act by implementing new technologies in: an automated nebulization system, a mechatronic system with compensatory role of alveolar recruitment, a mechatronic system of automated disinfection, ozone therapy supplemented with a laser anticoagulation system. The area of ventilator development is probably the one where the link between physics and medicine can be seen most directly; all techniques are underpinned by basic knowledge of the behavior of gases as volume and pressure are changed. Current mechanical ventilation technology has not seen an evolution in ventilation methodology, only a change in the human communication interface by replacing buttons with touchscreens, which does not offer an improvement in the medical act; it is only a marketing strategy by manufacturers and nothing more. When analyzing ventilator models produced between 1992-2020, it was found that they do not differ at all from those produced today in terms of the benefits offered to the patient, the only change being generated by the machine-human interface using touchscreens. The main components underlying the realization of this prototype mechanical ventilator are the following: a medical gas source, valve for priming the ventilator with oxygen, digital valve with pressure regulator, patient tubing, exhalation solenoid valve, pressure sensor, flow sensor, function generator with signal amplification system with digital display, ozone generator, anticoagulated laser system, electromagnetic parasitic signal recognition system, agitated patient warning system, 532 nm laser diode and power supply.

S3-1.9 (824) Brain–Computer Interface-Enabled Decision Support for Human Behavior Monitoring in Safety-Critical Contexts

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This paper proposes an advanced method for monitoring human behavior by integrating brain–computer interface technologies into intelligent decision support systems. Developed within a European research framework, the study combines multiple physiological sensing modalities, real-time biomedical signal processing, and artificial intelligence techniques to assess key cognitive states such as psychological stress, mental workload, and intentional deception. Two specialized platforms were designed and implemented: one for indoor use and controlled environments, and another for outdoor use and dynamic operational contexts. Both platforms were tested and validated in laboratory conditions as well as in realistic field scenarios involving cognitive and emotional challenges. The experimental results indicate that brain–computer interface-based systems can significantly improve situational awareness, enhance decision-making processes, and support psychological profiling, especially in high-stakes or safety-critical environments. This research highlights the growing importance of cognitive monitoring tools in applications such as healthcare, security, military operations, and advanced human–machine collaboration. Furthermore, the integration of neural and physiological data into decision systems opens new perspectives for adaptive and personalized technologies capable of responding to users' mental states in real time. The findings confirm the viability and potential of brain–computer interfaces as core components of future intelligent monitoring and support systems.

S3-1.10 (680) Assessment of the Effects of Spectral Non-Stationary of Sound Signals of Biosystems

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Modern bioengineering is aimed at using advanced technologies to develop new methods for studying and regulating biosystems. It covers a wide range of social problems related to medicine, agriculture, ecology and industrial industry. At the same time, to obtain the necessary information about the state of these systems and the processes occurring in them, the entire spectrum of natural manifestations of their vital activity is used. One of the aspects of obtaining such information is the study of biosignals in the acoustic range of the spectrum. However, acoustic signals in biosystems have characteristic features due to the stochastic non-stationary form of representation, which significantly complicates the selection of a useful signal. The authors studied the spectral non-stationarity of sound biosignals, and as an example considered the biosystem of a beehive, where these features are manifested to a significant extent. This is due to the fact that the sound signals of the honeybee biosystem manifest themselves as dynamic models of random processes carrying significant information not only in the form of parameters, but also in the form of local non-stationarities. The information component of such a model is quite multifaceted and is of interest both for theoretical analysis and for practical application.

S3-1.11 (691) Automated Deep Learning-Based Cell Viability Test for L929 Cells Using Phase-Contrast Microscope Images

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The study is dedicated to the development of mathematical models and software for addressing the task of automatically determining the number of viable cells in a studied culture based on the results of morphological analysis. The input data for the algorithms consist of microimages of a cell culture monolayer, obtained through phase-contrast and fluorescence microscopy. To enable visual differentiation of cells, a staining method is employed using specific DNA-binding dyes that interact differently with live and dead cells. These dyes penetrate dead cells, allowing their visualization under a fluorescence microscope, while live cells remain unstained. The L929 cell line, derived from mouse connective tissue, was selected as the research object for the development and testing of the created models and software. The operation of the developed algorithm comprises two stages. In the first stage, the number of non-viable cells is determined from fluorescence images using classical computer vision techniques. In the second stage, the total number of cells within the microscope's field of view is calculated from phase-contrast images, employing deep learning methods. For model training, a dataset was compiled consisting of 95 high-quality images of L929 cell monolayers, categorized into five subgroups based on morphological characteristics such as cell size, density, and membrane visibility. To enhance training efficiency, transfer learning was applied using the LIVECell dataset, which includes over 5,000 annotated phase-contrast microscopy images of cells visually similar to L929. Testing demonstrated that the developed system outperforms manual methods, achieving an error rate of 4–12% (comparable to or better than human performance) and a processing speed of less than 1 second per image. This tool holds promise for applications in biomedical research, diagnostics, and cytotoxicity studies, enhancing the efficiency and reproducibility of cell viability assessments.

S3-1.12 (830) The Clinical and Imaging Diagnostic Algorithm for Patients with Lumbar Neurocompressive Syndrome

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Acute low back pain, uncomplicated and lasting less than four weeks, without red flag signs typically responds well to medical treatment and physiotherapy. In such cases, imaging often does not reveal a specific cause of the pain. MRI is the most informative method for diagnosing lumbar radiculopathy, especially when conservative treatment fails. Currently, the national clinical protocol for imaging in lumbar radicular pain does not include a diagnostic algorithm for lumbar neurocompressive syndrome. A total of 102 patients with lumbar neurocompressive syndrome were examined. All patients underwent comprehensive clinical and neurological assessments. In one group of 51 patients, the diagnosis was established using MRI of the lumbar spine. In the other group of 51 patients, the diagnosis was based on lumbar spine X-ray imaging. Among patients in the first group, who were diagnosed primarily via MRI, 37 (72.5%) were examined during the acute phase of pain (within the first four weeks of symptom onset), despite the absence of red flag signs. Only 14 (27.5%) patients in this group underwent MRI after unsuccessful conservative treatment. All 51 patients in the second group, who presented with acute lumbar radicular pain without suspicion of serious pathology, underwent primary radiological examination of the lumbar spine in two views. The developed diagnostic algorithm can contribute to improving clinical decision-making and enhancing the quality of life for patients with lumbar neurocompressive syndromes.

S3-P28 (748) Ultrasound Biomicroscopy in Ocular Trauma: Impact on Management Decisions

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Ocular trauma is a significant cause of visual impairment worldwide and frequently affects the anterior segment, where precise and timely imaging is critical for diagnosis and treatment planning. The anterior structures - including the anterior chamber, angle, iris, ciliary body, lens, zonules, anterior choroid, and peripheral retina are often involved. Conventional methods such as slit-lamp biomicroscopy and anterior segment optical coherence tomography are frequently limited in the presence of opaque media or distorted anatomy. This case series aimed to evaluate the diagnostic utility and clinical impact of ultrasound biomicroscopy in anterior segment ocular trauma cases where conventional imaging was limited. Ultrasound biomicroscopy, a high-frequency ultrasound technique, provides high-resolution, cross-sectional visualization of the anterior segment even when traditional light-based imaging is inconclusive. Nine eyes of nine patients with ocular trauma evaluated at the “Timofei Mosneaga” Republican Clinical Hospital in Chisinau, Moldova were included. All patients had media opacities that limited conventional examination. Ultrasound biomicroscopy and posterior B-scan ultrasonography were performed either on the day of presentation or postoperatively, depending on the nature injury. In five blunt trauma cases, ultrasound biomicroscopy revealed findings such as hyphema, angle recession, iridodialysis, zonular deficiency, lens subluxation or dislocation, choroidal effusion, and anterior vitreous hemorrhage. In four penetrating trauma cases, common findings included hyphema, iridodialysis, anterior lens capsule rupture, ciliochoroidal effusion, and anterior vitreous hemorrhage. Ultrasound biomicroscopy findings directly influenced clinical decision-making in all cases by guiding surgical interventions, modifying conservative management plans, and enabling early detection of potential complications.

S3-P29 (751) Image Acquisition and Analysis of Conjunctival Microvascular Network

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In recent years, with the progress of image acquiring hardware and software, imaging of the bulbar conjunctiva as a variety of noninvasive observation method was frequently explored. Disorders that are commonly associated with microvascular complications, such as cardiovascular diseases and diabetes mellitus are of special interest regarding this aspect. The objective of this study was to establish a working model for gathering data that would enable the assessment of vascular alterations in the bulbar conjunctiva. A comprehensive conjunctival biomicroscopy was conducted, followed by the acquisition of video sequences using a camera attached to the slit-lamp through an adapter. These videos were then analyzed using an individually developed software to quantify microcirculation parameters. The video recordings were examined using a custom computer algorithm that provided valuable data on microcirculatory parameters as vessel diameter, tortuosity, blood velocity, and blood flow. Although the main focus of this study was to develop and present a functional and efficient system for data acquisition and analysis, it is worth noting that our preliminary findings show a degree of consistency and alignment with results reported in pioneering studies, thereby supporting the validity and potential of our approach. The developed model allows the semi-automatic determination of microcirculation parameters in the bulbar conjunctiva, which may be useful in quantifying microvascular dysfunction in a non-invasive manner.

SECTION S4

New technologies for personalized medicine

S4-1.1 (677) Predictive Utility of HLA Antigens in the Clinical Diagnosis and Stratification of Psoriatic Arthritis

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Psoriatic arthritis (PsA) is a chronic inflammatory disease with diverse clinical phenotypes, ranging from mild oligoarticular involvement to severe, erosive arthritis. Genetic predisposition, particularly human leukocyte antigen (HLA) alleles, plays a critical role in disease susceptibility and severity.

A prospective cohort study was conducted at the State University of Medicine and Pharmacy "Nicolae Testemițanu" between 2007 and 2024, enrolling 357 PsA patients. Participants were stratified into early PsA (<3 years disease duration) and late PsA (>5 years). HLA typing was performed using PCR-SSO methods, and associations with disease subtypes were analyzed through logistic regression. A predictive model was developed to estimate the probability of PsA phenotypes based on HLA alleles. HLA-B27 was strongly associated with axial PsA (OR=6.32, $p<0.001$), while HLA-B16(38) and HLA-B38 were linked to polyarticular and distal interphalangeal PsA, particularly in patients with severe radiographic damage. HLA-B13 correlated with distal interphalangeal involvement, whereas HLA-B7 demonstrated a potential protective effect (OR=0.51, $p=0.09$). The predictive formula integrating HLA markers enhanced PsA classification accuracy, with a mean absolute error (MAE) of 0.287. Our findings underscore the clinical relevance of HLA genotyping in PsA stratification and its potential role in personalized medicine. The developed predictive model may refine diagnostic algorithms, such as CASPAR, improving early detection and risk stratification. Future research should investigate HLA class II alleles, epigenetic interactions, and environmental factors to further optimize predictive approaches.

S4-1.2 (679) Planning Information-Efficient Procedures for Recovery Missing Medical Indicators in System Data Analysis

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Obtaining additional diagnostic information when providing emergency medical care always reduces the risk of making erroneous decisions. In this regard, hormonal indicators, as markers of injury severity, have a special information value. Recently, there has been a growing scientific interest in the use of quantitative tools and methods for studying the complex dynamics of hormones, especially during stress, reproductive processes and metabolism. This is due to the fact that the endocrine system is a complex network of levels of regulation of the patient's body, uniting all systems of the patient's body and having nonlinear dependencies on external influences on the patient's body. In this paper, the authors study the results of mathematical modeling procedures for restoring hormonal indicators based on regression using general medical indicators. Unlike existing restoration methods that rely on correlation interdependent indicators, the article presents a mathematical model for the objective function of restoration. This model estimates the possibility of effective restoration, which is both informational redundant and sign-based. It is important that the control sample is not required, since one of the arguments of the objective function is an additional indicator providing integral information on the severity of the injury. The objective function also facilitates planning the choice of factor dimensions for the regression recovery model.

S4-1.3 (704) Advancing Biomedical Engineering: An Agent-Based Approach to Pulmonary Edema Simulation

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Agent-based modeling (ABM) offers a robust framework for simulating complex physiological systems, yet its application to pulmonary edema (PE) remains underexplored. This study presents an innovative ABM, built in NetLogo, to simulate cardiogenic PE (CPE) by modeling extravascular lung water dynamics under hydrostatic pressure (HP) and oncotic pressure (OP). Using a simplified Starling equation $Q = k (HP - OP)$, the model defines a spatial environment (capillary, ACM, alveoli) with agents like water molecules and macromolecules. Parameter tweaks (e.g., HP increase) amplify edema, showcasing the model's flexibility. Results position this ABM as a leap forward in biomedical engineering, bridging theoretical fluid dynamics with dynamic visualization. Clinically, it lays the groundwork for decision-support tools, predicting PE progression for integration with patient-specific data. Educationally, its interactive interface empowers students to grasp PE mechanisms, enhancing learning through simulation. Limitations - constant permeability, no oxygenation - suggest refinement opportunities, such as adding gas exchange or variable ACM properties for non-cardiogenic PE. This work builds on prior ABM efforts while addressing a gap in respiratory modeling, offering a scalable platform for research and application. Future validation and extensions could transform it into a cornerstone of computational medicine, merging engineering precision with clinical and educational impact. This study underscores ABM's untapped potential in respiratory pathophysiology.

S4-1.4 (724) Molecular-Genetic Particularities of the NPC1L1 Gene rs2073547 Polymorphism in the Population of the Republic of Moldova

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This study determined the allelic frequencies and genotype distribution of the *NPC1L1* gene rs2073547 polymorphism in the population of the Republic of Moldova, offering foundational data for the implementation of personalized medicine in hypercholesterolemia management. Using the TaqMan genotyping method, the results showed a predominant A allele (78.6%) and a less frequent G allele (21.4%), indicating a genetic profile similar to that observed in European populations. Genotype frequencies revealed a high prevalence of the AA homozygous genotype (62.9%), followed by AG heterozygous (31.5%) and GG homozygous (5.6%) genotypes. The distribution was consistent with Hardy-Weinberg equilibrium ($\chi^2 = 1.629$, $p = 0.202$). Comparative analysis with European populations confirmed genetic similarities, although minor differences in AA and AG genotype frequencies were observed. The identification of G allele carriers—individuals with AG or GG genotypes—accounting for 37.1% of the studied group, highlights the potential for interindividual variability in the pharmacological response to ezetimibe. This finding underscores the importance of integrating pharmacogenetic testing into clinical practice to optimize therapeutic outcomes. Overall, the study supports the feasibility of applying molecular genetic techniques in Moldova and provides a scientific rationale for future pharmacogenetic research focused on improving ezetimibe efficacy, laying the groundwork for more effective, personalized strategies in the treatment of hypercholesterolemia in the Republic of Moldova.

S4-1.5 (730) The Prevalence of rs4149056 Polymorphism of the SLCO1B1 Gene in the Population of the Republic of Moldova

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Cardiovascular diseases (CVDs) remain the leading cause of mortality in the Republic of Moldova, accounting for over 55% of deaths from non-communicable diseases. Dyslipidemia is a significant modifiable risk factor for CVD, and statins, particularly rosuvastatin, are among the most effective lipid-lowering agents. However, inter-individual variability in statin response, including the risk of adverse reactions such as myopathy, has been linked to genetic factors. This study hypothesized that the frequency of the rs4149056 polymorphism of the SLCO1B1 gene in the Moldovan population would be similar to that of other European populations, given geographic and ethnic proximity, with implications for statin therapy optimization. The rs4149056 polymorphism encodes a Val174Ala substitution in the OATP1B1 hepatic transporter, altering statin pharmacokinetics. We genotyped 431 healthy Moldovan individuals aged 18–29 using TaqMan® SNP Genotyping Assays. The minor C allele had a prevalence of 20.8%, comparable to other European cohorts. Homozygous CC genotypes, associated with a high risk of statin-induced myopathy, were present in 3.5% of the study population. These findings emphasize the clinical relevance of pharmacogenetic screening for SLCO1B1 variants to guide statin therapy in Moldova. Implementing such screening in clinical practice may reduce the incidence of adverse reactions and improve lipid-lowering treatment outcomes. Our results represent the first data on SLCO1B1 pharmacogenetic variability in Moldova and support the growing field of personalized cardiovascular pharmacotherapy in Eastern Europe.

S4-1.6 (743) The Role of Thiol/Disulfide Balance in Children with Chronic Kidney Disease

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Thiols constitute the largest part of the antioxidant system with the ability to protect cells and tissues from oxidative stress (OS). Studies report that glutathione (GSH) depletion may lead to the induction of SO and several negative effects due to the impairment of the thiol/disulfide balance. The aim of the study was to determine changes in thiol/disulfide balance in children with chronic kidney disease (CKD). A prospective study was conducted on a group of 71 children with CKD and a control group of 71 healthy subjects. Thiol/disulphide homeostasis (total thiol, native thiol, reduced thiol, oxidised thiol and disulphide levels) was measured using spectrophotometric method and the results were statistically analysed. In patients with CKD, a significant reduction in total, reduced and oxidized thiol levels was recorded $498,472 \pm 99,192 \mu\text{M/L}$ vs $424,405 \pm 34,012 \mu\text{M/L}$ $p < 0.005$; $292,202 \pm 52,059 \mu\text{M/L}$ vs $338,152 \pm 93,333 \mu\text{M/L}$ $p < 0.005$; $132,202 \pm 70,742 \mu\text{M/L}$ vs $160,326 \pm 49,993 \mu\text{M/L}$ $p < 0.005$. Protein-bound thiol groups (SH) showed an increasing trend in the control group ($3,348 \pm 1,739$ vs $5,652 \pm 1,958 \mu\text{M/L}$ $p < 0.005$); while total and free SH groups were higher in patients with CKD ($138,018 \pm 30.28$ vs $103,941 \pm 12,424 \mu\text{M/L}$ $p < 0.005$; $91,575 \pm 14,385$ vs $87,342 \pm 11,048 \mu\text{M/L}$ $p < 0.005$). The study demonstrates the persistence of a pro-oxidant status in children with CKD. Thus, the assessment of dynamic thiol-disulfide levels may contribute to the diagnosis and monitoring of CKD as a marker of OS.

S4-1.7 (774) Challenges of Pediatric Tuberculosis under Current Conditions

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This study aimed to evaluate the current challenges in diagnosing and managing pediatric tuberculosis in the Republic of Moldova, with an emphasis on post-pandemic epidemiological dynamics. A retrospective observational study was conducted on 772 children aged 0–18 years diagnosed with TB and hospitalized at the IMSP Municipal Clinical Hospital of Phthisiopneumology, Chișinău, between 2019 and 2024. Data were collected from clinical records and the national TB monitoring system (SIME TB). Epidemiological context, risk factors, diagnostic pathways, clinical manifestations, and treatment outcomes were analyzed. Statistical analysis included both descriptive and inferential methods using Excel and SPSS, with calculation of **odds ratios** and **confidence intervals** to assess associations between variables. The incidence of pediatric TB followed a fluctuating trend over the last decade, with a marked decline during the COVID-19 pandemic and a sharp increase in 2023–2024 due to delayed case detection. Most cases (74%) were identified through active screening of household contacts. The age group 6–14 years was most affected (49%), though a significant proportion (34%) involved children under five. TB was associated with multiple risk factors in 67% of cases, particularly social vulnerability and comorbidities. The most common clinical forms included intrathoracic lymph node TB (56%) and primary TB complex (21%). Microbiological confirmation was achieved in 37% of cases. Complications such as pleurisy (13%) and atelectasis (11%) were frequent. Most patients responded favorably to standard anti-TB regimens, with only one recorded death.

S4-1.8 (786) Early Cognitive Impairment in Parkinson's Disease – Exploring the Vascular Contribution

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Cognitive impairment (CI) is a common non-motor symptom in Parkinson's disease (PD), usually seen in more advanced stages. However, early onset CI questions the contribution of other factors. A cross-sectional study was conducted on 409 PD patients aged 64.61(±6.63) years stratified by MoCA cognitive status at *Diomid Gherman* Institute of Neurology and Neurosurgery from 2020 to 2022 aiming to delineate the profile of early PD-CI patients. Clinical evaluation and standardized questionnaires were used to assess PD and vascular status. Brain structure was examined using 1.5 Tesla MRI. Epi Info™ software was used for statistical analysis.

PD-CI subjects registered worse non-motor symptoms ($p=0.002$), depression ($p=0.004$) and apathy ($p=0.021$) levels; had akinetic-rigid phenotype ($p=0.002$) requiring greater LEDD ($p<0.01$) compared to those without CI. Up to 93.5% of PD-CI subjects had cerebrovascular risk factors, the majority multiple ones. Hypertension, atherosclerosis and dyslipidemia prevailed. Statistically fewer PD-CI subjects administered antiarrhythmic medication (9.5% vs. 4.9%, $p<0.05$) despite atrial fibrillation diagnosis. Brain CSVD-related MRI markers were more common in PD-CI individuals – correlating to the ventricular system dilation (35.3% vs. 22.3%, $p=0.015$) and lacune number (7.79 ± 4.95 vs. 4.00 ± 2.39 , $p=0.044$). White matter hyperintensities were more frequent in the periventricular white matter (53.9%), relative to the deep regions (45.7%).

The study revealed that early PD-CI involved poorer clinical status, higher vascular risk and inadequate preventive care. Results were supported by specific CSVD-MRI markers: internal atrophy and increased number of lacunas; indicating the need for combined clinical and imaging assessment.

S4-1.9 (803) Toward Personalized Hypertension Therapy: Evaluating NPHS1 and TRIB3 Genetic Polymorphisms

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Personalized hypertension management aims to optimize therapeutic efficacy while minimizing adverse effects by selecting the most suitable medication for each patient. Pharmacogenetic research plays a critical role in this approach by identifying genetic variants that influence interindividual differences in drug response. However, translating these findings into clinical practice requires validation in specific populations to confirm known associations and potentially uncover novel, population-specific variants. This study investigates two single nucleotide polymorphisms (SNPs): rs3814995 in the NPHS1 gene and rs2295490 in the TRIB3 gene, both of which are relevant to antihypertensive therapy. The NPHS1 gene encodes a member of the immunoglobulin family of cell adhesion molecules with the role in glomerular filtration barrier in the kidney and may modulate the response to angiotensin II receptor blockers such as losartan. The TRIB3 gene encodes a pseudokinase that inhibits AKT kinase by direct binding, potentially affecting the action of angiotensin-converting enzyme inhibitors like imidapril. Genotype frequencies for both SNPs were analyzed in a local cohort to evaluate potential associations with the efficacy of prescribed antihypertensive agents. Identifying such pharmacogenetic associations may enable the development of personalized treatment protocols that improve patient adherence and long-term blood pressure control. The results contribute to a growing body of evidence supporting the integration of genetic screening into hypertension management and provide a foundation for future clinical studies focused on individualized therapy.

4-1.10 (810) Epidemiological and Virological Characteristics of Acute Viral Respiratory Infections Associated with Comorbidities

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Influenza, acute upper respiratory tract infections (AURIs) and severe acute respiratory infections (SARIs) are the most common infectious diseases worldwide. Global monitoring of antigenic variations of influenza viruses is essential for detecting the emergence of new epidemic and pandemic strains. Frequent antigenic variations require periodic updates of vaccines to match new variants emerging during influenza epidemics and the use of data to improve the influenza vaccine component as well as testing the sensitivity of antiviral preparations sensitive to Oseltamivir and Zanamivir. Epidemiological features of the evolution of influenza, AURIs and SARIs, depending on the phenotypic and genotypic characteristics of the dominant and codominant strains of influenza A(H1N1) pdm09, A(H3N2) and B in the Republic of Moldova, based on the routine and sentinel epidemiological surveillance system. The results obtained allowed to improve the surveillance and response measures for influenza, acute upper respiratory tract infections and severe acute respiratory infections manifested by reducing the incidence of morbidity and mortality from the aforementioned infections, in the group at increased risk of infection.

The presence of influenza viruses was significant, with a predominance of the A(H1N1)pdm09 virus in the 30-64 age group and of the A(H3N2) and B viruses in children aged 5-14 years. The isolated influenza virus strains were similar to those included in the vaccine cocktail recommended by the WHO, being sensitive to Oseltamivir and Zanamivir. Among comorbidities, renal infections are in third place, preceded by cardiovascular and respiratory ones. All cases of death are unvaccinated patients.

S4-1.11 (813) Predictive Value of Biochemical Markers on Mortality in Hospitalized COVID-19 Patients in Intensive Care Units

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Mortality among COVID-19 patients hospitalized in intensive care units (ICU) remains a major topic of interest. The evaluation of biochemical markers can provide valuable predictive information for the prognosis of these patients. This study aimed to investigate the predictive value of certain biochemical markers on mortality among COVID-19 patients in the ICU. The study included a total of 3,223 patients hospitalized in IMSP IMU during the period 2020-2022, of which 965 died and 2,258 survived. The values of the following biochemical parameters were analysed: ALAT, ASAT, total bilirubin, conjugated bilirubin, urea, creatinine, total protein, glucose, CRP, and sodium. The W-Mann-Whitney test was used to compare the mean values of the biochemical parameters, and the p-value < 0.05 was considered statistically significant. Differences between the "deceased" and "survived" groups were evaluated using the Wilcoxon rank-sum test. Elevated levels of ASAT (p<0.001), urea (p<0.001), creatinine (p<0.001), glucose (p<0.004), and CRP (p<0.001) were associated with an increased risk of mortality, while lower levels of total protein (p<0.001) were predominantly observed in deceased patients. Bilirubin and ALAT did not show statistically significant differences. The identified biochemical markers could be used for risk stratification and optimization of clinical management among COVID-19 patients in the ICU.

S4-P30 (675) Statistical Analysis of Exosome Diagnostic Methods in Patients with Schizophrenia

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Specific alterations in exosomes and their characteristics may serve as potential biomarkers for schizophrenia. By applying statistical methods, it is possible to determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of exosome-based diagnostic tests in patients with schizophrenia. This study aimed to analyze the diagnostic performance of exosome-based methods in identifying schizophrenia, based on sensitivity and specificity parameters, and to assess the reliability and clinical significance of these approaches. A systematic search was conducted using the PubMed, MEDLINE, Scopus, and Web of Science databases. Inclusion criteria comprised English-language publications from 2019 to 2025 that reported statistical measures of sensitivity and specificity for exosome-based tests in schizophrenia, including control groups. Out of 21 sources published between 2014 and 2025, 9 studies met the inclusion criteria. Online statistical calculators were employed to evaluate the reliability of exosome-based diagnostic methods. Statistical analysis predicted that 80% of patients with a positive test result truly have schizophrenia, while 77.039% of individuals with a negative test result were correctly identified as healthy. The area under the ROC curve (AUC) was 0.6781, indicating that while the model is not ideal, it still demonstrates moderate discriminatory ability, distinguishing between schizophrenia patients and healthy individuals with 67.8% accuracy. Exosome-based tests hold potential for screening, prognosis, and disease monitoring in schizophrenia. Although current diagnostic accuracy is moderate, these findings support further investigation and development of exosome-based biomarkers in clinical psychiatry.

S4-P31 (681) Statistical Analysis of Combined Screening and Diagnostic Tests for Postpartum and Schizophrenia-Like Disorders

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The Edinburgh Postnatal Depression Scale (EPDS) is widely used for diagnosing postpartum depression. However, there is a lack of specific tools for diagnosing postpartum psychosis. Common scales such as PANSS and BPRS are not adapted for diagnosing these conditions. The Postpartum Psychosis Evaluation Scale (PPES) is the only adapted tool for postpartum psychosis, with a sensitivity of 85.2% and specificity of 78.6%, but it is not widely used in global practice and requires further research. Due to this limitation, many specialists rely on combined diagnostic methods.

This study conducted a statistical evaluation of combined diagnostic tests for postpartum disorders, including the following combinations: SCID/DSM-IV/EPDS, MINI/EPDS, EPDS/DSM-V/MINI, EPDS/DSM-V/SCID-V/BSI-53, BSI-18/GSI. Databases such as PubMed, MEDLINE, Scopus, Cochrane Library, and ResearchGate were searched. Articles containing data on sensitivity and specificity were selected in the sources found. Statistical analysis included correlation coefficients, normality tests, ANOVA, and covariance analysis.

The analysis revealed a moderate negative correlation between the sensitivity and specificity of diagnostic tools. Combined tests, including EPDS, MINI, SCID, and BSI-18, improved both sensitivity and specificity. The area under the ROC curve (AUC) was 0.719, indicating moderate diagnostic accuracy.

Combined diagnostic approaches are effective for diagnosing both postpartum depression and psychosis. However, there is a trade-off between sensitivity and specificity, making it essential to use multiple tools for optimal results. Further research is needed to enhance these methods in clinical practice.

S4-P32 (682) Serum Levels of Interleukin-6 and Tumor Necrosis Factor-Alpha in Renal Anomalies and Diseases in Children

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Recently, impressive progress has been made in understanding the etiology and pathophysiological mechanisms involved in renal diseases in pediatric patients. Research shows that current treatment methods can be useful if they are applied to the early stages of the disease and sensitive early biomarkers are identified. In this regard, an important role would be played by the evaluation of cytokines at the onset and clinical-evolutionary stages of the pathology. Highlighting the peculiarities of the biohumoral system as well as some practical aspects of diagnosis, treatment, medical and surgical resolution in children with congenital renal and urinary tract anomalies (CRUA). Clinical, imaging, biochemical, pathomorphological, immunohistochemical predictors were evaluated in 100 patients aged 0-18 years with CRUA, including 35 - with congenital hydronephrosis (HN), 45 - with vesicoureteral reflux (VUR) and 20 - with megauretero-hydronephrosis (MUH). The comparison group consisted of 100 practically healthy children. The paraclinical examination included the assessment of specially selected serum biomarkers - IL-6 and TNF- α . Results increase in the number of children with CRUA in recent decades, as well as the serum level of IL-6 by 2-4 times and TNF- α by 2 times and more compared to the control group, was demonstrated. The obtained data reveal the informativeness and high value of estimating the serum level of IL-6 and TNF- α CRUA and which can be used as sensitive biomarkers, valuable in assessing the activity of the inflammatory process but also the effectiveness of the applied treatment.

S4-P33 (688) Assessment of Oxidative Stress Related to Clinical and Imagistic Peculiarities in Hospitalized Patients with Community-Acquired Pneumonia and Chronic Heart Failure

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Diagnosing community-acquired pneumonia (CAP) in patients with chronic heart failure (CHF) can be challenging. Oxidative stress (OS) plays an important role in the development of CAP and is involved in many cardiovascular diseases, including CHF. We aimed to evaluate the clinical and radiological features, as well as oxidative stress markers, in patients diagnosed with both CAP and CHF. In this study were included 210 patients and were categorized into two groups: Group 1 (n=105) included patients with CAP and coexisting CHF, while Group 2 (n=105) included patients with CAP without CHF. The age of patients in the study group ranged from 50 to 92 years, with a mean of 70.6 ± 8.89 years (95% CI [68.8–72.3]; Mn = 70.0; IQI = 11), with no significant differences between the groups. Worsening of dyspnea was observed in 98 patients (93.3%) in Group 1, significantly more than in Group 2, where it was reported in 73 patients (69.5%), ($p < 0.0001$). Bilateral pneumonia was slightly more frequent in Group 1 compared to Group 2—63 patients (60.0%) versus 57 patients (54.3%)—though the difference was not statistically significant, ($p = 0.515$). Pleural effusion was notably more common in Group 1, occurring in 41 patients (39.0%) compared to 14 patients (13.3%) in Group 2, ($p < 0.0001$). Additionally, total antioxidant activity (TAA), measured by the CUPRAC method, was significantly higher in Group 1 (6.70 ± 4.62) than in Group 2 (4.99 ± 4.29), ($p = 0.006$). These findings suggest that bilateral pneumonia, presence of pleural effusion, worsening of existing dyspnea, and elevated TAA values (CUPRAC method) may serve as valuable indicators for the early diagnosis of CAP in patients with CHF.

S4-P34 (705) Health-Related Quality of Life in Autoimmune Hypothyroidism: A Prospective Cohort Study with Cross-Sectional Comparison Using ThyPRO-39

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With the shift in clinical paradigms over the past decade toward value-based healthcare, quality of life (QoL) has become a critical measure of treatment success in chronic endocrine conditions such as autoimmune hypothyroidism (AH). Many patients report persistent symptoms despite achieving biochemical euthyroidism, underscoring the need for patient-reported outcome (PRO) assessment. This study assessed health-related quality of life (HRQoL) in newly diagnosed AH patients before and after levothyroxine therapy, compared to healthy controls. The goal was to evaluate whether normalization of thyroid hormone levels translates into meaningful improvements in patient-reported well-being. A Prospective cohort of 64 AH patients (20-65 years) was evaluated using the ThyPRO-39 questionnaire. Patients completed the instrument at diagnosis and after four months of levothyroxine therapy. Their responses were compared with those of 64 age and sex matched healthy individuals. AH patients demonstrated significantly impaired QoL at baseline compared to controls, as indicated by higher composite ThyPRO-39 scores ($p = 0.015$). Following levothyroxine therapy, patients exhibited statistically and clinically significant improvement across multiple domains, with a significant reduction in composite scores ($p < 0.001$). Notably, patients with overt hypothyroidism experienced greater improvements than those with subclinical disease. Despite significant improvements following levothyroxine therapy, some QoL deficits persisted, particularly in cognitive and psychosocial domains. These impairments may reflect the effects of thyroid autoimmunity and psycho-social factors rather than hormone deficiency alone. These findings highlight the importance of incorporating validated tools such as ThyPRO-39 into routine clinical practice in Moldova to capture patient-reported outcomes beyond biochemical parameters and to support more personalized management.

S4-P35 (714) Peculiarities of Atypical Forms of Chronic Inflammatory Demyelinating Polyneuropathies

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Chronic Inflammatory Demyelinating Polyneuropathy (CIDP) is an acquired, immune-mediated neuropathy characterized by chronic, progressive, or relapsing motor and sensory dysfunction caused by peripheral nerve demyelination. The mechanism of nerves damage is presumed to be immune mediated. Despite advances in diagnosis, CIDP remains a diagnostic challenge and is sometimes confirmed only by the patient's response to specific immunomodulatory therapies. Atypical forms account for approximately 50% of all CIDP cases and are more frequently identified with the aid of supplementary diagnostic methods.

The aim of this study was to establish clinical and laboratory criteria for the diagnosis of atypical CIDP forms. Two patient groups were analyzed: 30 with typical CIDP and 30 with atypical CIDP. All participants underwent nerve conduction studies, blood biochemical testing, serum protein electrophoresis, and immunofixation. Functional disability was assessed using the Overall Neuropathy Limitations Scale (ONLS).

In typical CIDP, the degree of functional disability correlated directly with the severity of upper limb muscle weakness. In contrast, patients with atypical CIDP demonstrated predominant impairment of proprioception and deep sensory modalities, with relative preservation of muscle strength. Nerve conduction studies are not considered a gold standard for diagnosing atypical sensory CIDP. However, predictive equations derived from multiple regression analysis may help forecast the progression of disability in CIDP patients.

S4-P36 (717) Changes in Intestinal Electrical Bioactivity in Postoperative Intestinal Failure Syndrome

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Postoperative intestinal insufficiency syndrome (IIS) is a complex dysfunction of the motor, barrier and digestive functions of the intestine, frequently associated with abdominal sepsis or multiorgan failure. Correct and early assessment of gastrointestinal motility disorders is essential for improving postoperative prognosis. In this study, changes in intestinal electrical bioactivity were investigated by computerized electrogastroenterography (EGEG) in 187 patients with abdominal surgical pathologies and IIS, divided into three grades according to the severity of the condition. The control group included 30 healthy volunteers.

EGEG permitted the non-invasive quantification of absolute and relative bioelectric potentials at the level of gastrointestinal segments, as well as of the coordination coefficients between pacemaker zones. Results revealed a progressive decrease in the total bioelectric activity of the gastrointestinal tract (Ps), correlated with the severity of IIS, from 126.2 ± 18.2 mV (grade I) to 41.93 ± 15.7 mV (grade III). Duodenal activity showed a constant decrease, becoming a predictive marker of unfavorable evolution. Despite the reduction in absolute activity, relative gastric power remained stable, suggesting a compensatory role in maintaining peristalsis.

Changes in coordination coefficients indicated neuromuscular dysregulation, with hyperactivity at the gastroduodenal junction and inhibition at the duodenojejunal and ileocecal junctions. The results of the study support the clinical utility of EGEG in the early detection of physiological changes associated with IIS and in guiding the appropriate treatment. EGEG is a reliable method for the functional assessment of gastrointestinal motility and postoperative patient prognosis.

S4-P37 (767) Risk Stratification in Pulmonary Thromboembolism: Validation of the ECOAGE Score

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Pulmonary thromboembolism (PTE) remains a leading cause of cardiovascular morbidity and mortality. Early diagnosis and risk stratification are crucial for improving patient outcomes. Several clinical risk models have been proposed, but a simple, comprehensive scoring system that integrates easily accessible clinical parameters is still needed. We aimed to validate the ECOAGE score, a novel composite model integrating age, right ventricular dysfunction (RV), and venous duplex findings of deep venous thrombosis (DVT) for predicting PTE in patients with suspected pulmonary thromboembolism. Methods: In this prospective observational study, 100 patients presenting with suspected PTE at Saint Trinity Hospital from 2022 to 2025 were enrolled. Clinical data, echocardiographic parameters, and venous duplex ultrasound findings were collected. The ECOAGE score was calculated for each patient, and its ability to predict PTE was assessed using receiver operating characteristic (ROC) curve analysis. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated. A Cox proportional hazards regression model was used to evaluate the relationship between the ECOAGE score and clinical outcomes. Results: The ECOAGE score demonstrated excellent discriminatory power for identifying patients at high risk for PTE, with an AUC of 0.81. At a threshold of ≥ 5 points, the score achieved 82% sensitivity and 70% specificity. The score also effectively stratified patients based on clinical outcomes, with high-risk patients showing increased morbidity and hospital stays. Right ventricular dysfunction and DVT were significantly associated with the presence of PTE. Conclusions: The ECOAGE score is a reliable, simple, and effective tool for predicting pulmonary thromboembolism in patients with suspected PTE. It offers an easily applicable risk stratification method that could improve clinical decision-making and early management of PTE, especially in resource-limited settings. Further studies with larger cohorts and longer follow-up are required to validate its prognostic value in diverse populations.

S4-P38 (790) Predictive Factors of Major Acute Coronary Events in Patients with Chronic Coronary Syndrom

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Chronic Coronary Syndrome (CCS) is a common condition associated with an elevated risk of Major Adverse Cardiac Events (MACEs), such as myocardial infarction, cardiovascular death, and urgent revascularization. Early identification of clinical and paraclinical predictors is essential for risk stratification and secondary prevention. This study aimed to identify independent clinical, biochemical, and imaging predictors associated with the risk of MACEs in patients diagnosed with CCS. We conducted a retrospective cohort study including 132 patients diagnosed with CCS between 2023 and 2025. Clinical characteristics, laboratory data, imaging results, and electrocardiographic findings were analyzed. Univariate and multivariate Cox regression models were employed to assess risk factors. A random forest algorithm was used to evaluate variable importance. The predictive model's performance was assessed using Harrell's C-index. During a median follow-up of 2.2 years, 16% of patients experienced MACEs. Independent predictors included diabetes mellitus (HR 1.92; 95% CI 1.45–2.54), reduced left ventricular ejection fraction (LVEF <40%) (HR 2.15; 95% CI 1.63–2.84), and multivessel coronary artery disease (HR 1.89; 95% CI 1.41–2.53). The predictive model achieved a C-index of 0.78. Diabetes mellitus, reduced LVEF, and multivessel coronary artery disease are strong, independent predictors of MACEs in patients with CCS. These findings support the integration of clinical and imaging data into personalized risk stratification tools to improve secondary prevention.

S4-P39 (791) Cardiovascular Risk Prediction Model Tailored for Chronic Kidney Disease Patients

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Cardiovascular disease (CVD) continues to represent the primary cause of morbidity and mortality in individuals with chronic kidney disease (CKD), accounting for a significant proportion of premature deaths in this vulnerable population. Patients with CKD are up to 20 times more likely to die from cardiovascular causes than to progress to end-stage renal disease. This elevated risk cannot be fully explained by traditional cardiovascular risk factors alone—such as hypertension, diabetes, dyslipidemia, or smoking—as the pathophysiology of CVD in CKD involves a complex interplay of both traditional and non-traditional mechanisms. These include chronic inflammation, endothelial dysfunction, vascular calcification, oxidative stress, anemia, and disturbances in calcium-phosphorus metabolism. Furthermore, conventional cardiovascular risk prediction models (e.g., Framingham Risk Score) were developed for the general population and often fail to accurately stratify risk in CKD patients. This limitation arises from the exclusion of renal-specific variables such as estimated glomerular filtration rate (eGFR), proteinuria, and markers of systemic inflammation, which have been shown to independently predict cardiovascular outcomes in CKD cohorts. As a result, there is a growing recognition of the need for CKD-specific cardiovascular risk models that account for the unique biological and clinical characteristics of this group. This article presents a cardiovascular risk prediction model specifically tailored for CKD patients, integrating both conventional risk factors and CKD-specific variables (e.g., estimated glomerular filtration rate [eGFR] and inflammation markers). The model was developed and validated using data from a CKD cohort and demonstrated improved accuracy. The study underscores the importance of personalized risk assessment tools in guiding preventive strategies and clinical decision-making for CKD patients at high risk of cardiovascular events.

S4-P40 (802) Predictive Models of Sympathovagal Balance Based on the Parameters of Controlled Breathing Pattern

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The aim of this study was to develop predictive models for assessing the influence of respiratory pattern on sympathovagal balance, expressed by the LF/HF ratio of heart rate variability (HRV). The research was carried at the Department of Human Physiology and Biophysics, using data obtained from the analysis of seven experimental breathing models. Respiratory parameters were recorded by inductance respiratory plethysmography (IRP), using the "Visuresp" and "CapnoStream20" systems, and HRV analysis of the ECG signal, recorded using BIOPAC Systems MP100, was performed using the "Kubios HRV Standard" program. In statistical processing, multivariate analysis with the Backward variable selection method was applied, using the IBM SPSS Statistics 26.0, to identify respiratory parameters with significant predictive value. The results showed that respiratory minute volume (RMV) and total respiratory cycle duration (Tt), measured under resting breathing conditions, have an important predictive value in estimating sympathovagal balance in abdominal (AR) and controlled breathing (R5/5) patterns. Reducing RMV and extending the duration of the respiratory cycle through conscious control of the respiratory pattern favored the increase of parasympathetic influence and the decrease of sympathetic activity. The conclusions support the use of breathing regulation techniques, especially abdominal and controlled breathing, as effective non-pharmacological methods for optimizing autonomic function, with applicability in health promotion and prevention of disorders associated with autonomic imbalance.

S4-P41 (780) The Hidden Arrhythmic Toll of Antitumor Therapy in Non-Hodgkin Lymphoma

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Cardiovascular diseases are among the leading causes of mortality in patients with various malignancies. While cardiac dysfunction linked to antitumor therapy has received considerable attention in the literature, arrhythmia remains an important complication—ranging from benign to life-threatening. This prospective study followed 127 non-Hodgkin lymphoma patients, assessed by 24h Holter ECG before and six months after antitumoral treatment. The most prevalent arrhythmic events detected were supraventricular tachycardia, ventricular and supraventricular extrasystoles. The PQ interval did not change overall during the study, but it was significantly prolonged in patients receiving high-dose cyclophosphamide ($p < 0.001$), with no effect observed from doxorubicin. The QTc interval increased significantly from 403.2 ms to 432.8 ms ($p < 0.001$), showing a moderate correlation with doxorubicin dose and a stronger association with treatment regimens that included cyclophosphamide ($p < 0.001$). Approximately 10% of patients developed a QTc ≥ 480 ms ($p = 0.0026$), and 17.4% had QTc values between 450–480 ms (for men) and 460–480 ms (for women) ($p = 0.0001$). These changes were mainly linked to high-dose cyclophosphamide, with no significant correlation observed for doxorubicin. During antitumor treatment, arrhythmic events increased, correlating with high doses of doxorubicin and cyclophosphamide. High-dose cyclophosphamide was linked to prolonged PQ and QTc intervals and more frequent QTc ≥ 480 ms.

S4-P42 (761) Implementation of an Advanced Surgical Strategy for the Correction of Strabismus

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Strabismus is an eye condition that manifests itself through the deviation of one eye axis in relation to the other. The pathology involves a lack of coordination between the extraocular muscles that prevents each eye from focusing on the same point in space and prevents binocular vision, affecting the perception of space.

Purpose of the work: Local development of the prototype of the surgical device for the treatment of strabismus and the production of the prototypes necessary for the implantation of the developed device.

The developed device consists of two parts: the first part is equipped with an ear, the second part has a partition at the proximal end, the distal end of the limb forming two ears. The length adjustment mechanism consists of three parts: a tube that bifurcates into two arms, a parallelepiped tube and the electronic barbell.

Under the conditions of founding the surgical method and the native device, we will contribute to reducing the number of repeated surgical interventions, decreasing the postoperative hospitalization time, reducing the rehabilitation period, especially in children, reducing budgetary expenses for long-term hospitalizations, and increasing the population's accessibility to surgical treatment of strabismus with the use of the proposed device.

The developed device will ensure surgical intervention for strabismus correction with maximum accuracy, without blood circulation disruption, will function without disturbing the insertion site and without resection of the ocular muscles, with the possibility of adjusting the length without a new intervention.

S4-P43 (781) Predictive Model for Estimating the Risk of Major Adverse Cardiovascular Events in Patients Undergoing Dual Antiplatelet Therapy with Aspirin and Clopidogrel, Including the CYP2C19*2 Polymorphism

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High platelet reactivity (HPR) during clopidogrel treatment is influenced by both genetic and clinical factors, increasing the risk of major adverse cardiovascular events (MACE). This study aimed to develop a multivariate prediction model for MACE in Moldovan patients treated with clopidogrel after percutaneous coronary intervention (PCI) with drug-eluting stents (DES). A total of 172 patients undergoing their first PCI after acute coronary syndrome were included, all treated with dual antiplatelet therapy (clopidogrel and aspirin) for 6–12 months. MACE was defined as myocardial infarction, angina pectoris, stent thrombosis, or sudden death.

Multivariable logistic regression identified several independent predictors of MACE. Patients with reduced-function CYP2C19 alleles (intermediate or poor metabolizers) had a significantly higher MACE risk compared to normal metabolizers (OR = 7.609, 95% CI: 2.341–24.725). A prior myocardial infarction also increased the risk (OR = 5.909, 95% CI: 1.708–20.439). Abdominal circumference was a significant anthropometric factor, with each additional centimeter increasing MACE risk by 4.8% (OR = 1.049, 95% CI: 1.002–1.098). Procedurally, longer stent length was associated with increased risk (OR = 1.052, 95% CI: 1.009–1.097). The model demonstrated good discriminative ability, with an area under the ROC curve (AUC) of 0.866.

These findings support the use of integrated genetic and clinical data to identify high-risk patients and guide personalized antiplatelet therapy after PCI.

SECTION S5

Bioinformatics, e-health and telemedicine

S5-1.1 (684) Modeling of Biomedical Processes Using MATLAB

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At present, mathematical statistics methods are widely used to study natural processes, allowing to create a mathematical model of the process, which implies the possibility of predicting its state at a certain point in time. At the same time, by setting the conditions of input variables and external influences on the process, the researcher can estimate the result of such an impact on the state of this process. This is especially important in the study of biomedical processes, which are complex multifactorial systems with nonlinear connections due to the peculiarities of the functioning of a biological object - a patient. The use of specialized software significantly simplifies these studies. However, the features of obtaining and using the initial data for such an analysis largely depend on the method of medical diagnostics and hardware used for this purpose. The authors considered in the work the features of using the MATLAB software environment for solving problems in the field of biomedical modeling and predicting the dependence of the patient's condition on the influence of external factors. At the same time, the main attention is paid to the features of the preparation and use of statistical data of biomedical processes and the technology of using the MATLAB software environment for problems of this segment of mathematical statistics. The authors studied the types and kinds of models of biomedical processes and compared their capabilities in terms of the quality of modeling results using the example of using natural data on the immunoresistance of patients.

S5-1.2 (718) Computational Modeling of Age-Related Atherosclerotic Plaque Evolution and Mechanical Vulnerability Assessment

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This study aims to computationally explore the age-related evolution of atherosclerotic plaques with a specific focus on the mechanical vulnerability of arterial tissues. The research investigates how structural and material alterations in aging arteries contribute to increased plaque vulnerability, which is a major determinant in the risk of cardiovascular events. The ultimate goal is to enhance our mechanistic understanding and predictive capacity regarding vulnerable plaque formation using patient-specific conditions across different age profiles. To address this objective, the study builds a simulation-based framework that links arterial tissue aging with the mechanical environment contributing to plaque formation and potential rupture. It begins with a geometric reconstruction of arterial sections exhibiting early-stage atherosclerotic plaques. These geometries are then subjected to virtual aging, incorporating age-related changes in plaque composition, focusing on lipid pool growth. Finite element simulations estimate strain and stress fields, identifying potential zones of mechanical failure. The model is iteratively adapted to reflect known histological and clinical patterns of plaque progression and vulnerability. The study identifies specific mechanical indicators—such as increasing strain gradients and stress concentrations, that correlate with experimentally observed plaque rupture locations in aged arterial segments. This approach enables early identification of high-risk plaques based on patient-specific aging patterns, paving the way for more accurate clinical risk stratification and the design of personalized therapeutic strategies. Moreover, the findings support the development of preventive interventions that consider age-related biomechanical weakening of arterial tissues.

S5-1.3 (731) The Pangenome Variability Index: A Quantitative Measure for Assessing Gene Content Diversity in Microbial Genomes

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Accurately characterizing the structure and variability of microbial pangenomes is essential for understanding genome evolution, adaptation, and functional diversity. Traditional descriptive measures such as genomic fluidity and the openness coefficient (α) have provided valuable insights into gene content diversity and pangenome expansion dynamics. Still, they often lose resolution in transitional genome states where conserved and accessory genes coexist. Here, we introduce the pangenome variability index (PVI), a frequency-aware sampling-independent measure that captures gene presence-absence variability across microbial genomes. Unlike the openness coefficient (α) or genomic fluidity, PVI exhibits a unimodal response across the core genome continuum and peaks in intermediate regimes, reflecting maximal compositional heterogeneity. We validate PVI across simulated pangenomes ranging from fully open to fully closed states and show that it captures dimensions of gene content structure orthogonal to conventional measures. Unlike classical measures that saturate in transitional regimes, PVI retains discriminative power and offers a robust, interpretable summary of genomic variability. We recommend integrating PVI into pangenome analysis pipelines as a complementary measure to guide comparative analyses, especially in studies targeting transitional genome architectures and genome evolution in dynamic environments. Future directions include extending PVI to strain-resolved metagenomics, functional annotation layers, and longitudinal analyses of microbial communities.

S5-1.4 (785) Spatial Representation of Three-dimensional X-ray CT Segmentation Data Using Machine Learning and Mixed Reality

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This study proposes an intuitive and high-precision visualization system that integrates machine learning-based segmentation of CT images with mixed reality (MR) technology. Traditional surface rendering techniques often have limitations, such as including irrelevant structures due to similar densities, dependence on threshold settings, and loss of anatomical detail. To address these issues, we utilized MONAI Label to automatically segment key anatomical structures from abdominal CT scans and constructed 3D surface models for each segmented organ. The system incorporates a spatial reality display (SONY ELF-SR2) and a gesture-based motion capture device (Leap Motion Controller 2) to enable users to manipulate 3D models intuitively without physical contact. Reconstructed cross-sectional images and segmented annotations are displayed as 3D textures and overlaid on the surface models using stencil buffer techniques. Users can freely select and hide specific organs via finger gestures, and dynamically adjust cross-sectional positions to explore internal structures. Experimental results demonstrated that the proposed system significantly enhances spatial understanding of complex anatomical configurations. The system is particularly suited for preoperative planning, medical education, and patient communication by enabling selective visualization and intuitive manipulation. The results of this study are expected to serve as a foundation for new three-dimensional visualization technology that facilitates understanding of complex internal structures in clinical settings, enabling safer and more accurate diagnosis and surgical support.

S5-1.5 (823) Features of Modeling Insulin Resistance Processes in the MatLab Application Package

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The problems of immunodeficiency, as well as the possibility of controlling the processes of carbohydrate metabolism in the patient's body, are one of the key tasks of modern immunology. The complexity of calculating and predicting the results of insulin therapy leads to the need to search for new solutions and methods for predicting insulin resistance processes and assessing the impact of various drugs on the patient's body. One of the possible directions for improving this analysis is the use of mathematical statistics, and in particular, modeling biomedical processes in the patient's body. Methods of mathematical statistics allow us to determine the dependencies of the results of these processes on the factors influencing them with external and internal an influence, which contributes to more effective diagnostics of the condition and prediction of treatment results. The use of computer methods for processing statistical information can significantly increase the efficiency of biomedical research, expand the scope of their application and provide a higher quality result. The authors analyze this possibility using the MatLab application package. This study is based on the initial data of a full-scale experiment conducted in 2022-2024 at Sahlgrenska Academy Gothenburg, Sweden. The aim of this study is to determine the features of modeling biomedical processes of carbohydrate metabolism in the patient's body and to create a methodological basis for subsequent scientific medical research in this area.

S5-1.6 (697) Remote Monitoring of Human Gait Parameters During Post-Traumatic Rehabilitation of the Musculoskeletal System

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While the biodynamics of walking have been extensively studied in medicine, particularly in prosthetics, current gait analysis methods do not offer a comprehensive assessment of "normality" during rehabilitation. Furthermore, no dedicated hardware tools exist for long-term monitoring of post-traumatic patient rehabilitation. This highlights the particular relevance of individual monitoring, especially in the later stages of rehabilitation and in real-world conditions. The study and mathematical description of normal versus pathological gait, using data from Inertial Measurement Unit (IMU) devices, are crucial for developing effective methods for such patients. This paper explores the possibility of developing generalized walking parameters. A key feature is the utilization of difference angles between lower limb segments across three coordinates. The analysis employs data from four sensors, including accelerometers and gyroscopes. The analysis was carried out on the gait of four individuals, both during normal walking and while using a treadmill at different speeds. Gait with limited mobility in one leg was also assessed. Parameters for gait monitoring and correction were calculated and validated based on existing studies on leg biomechanics. These results formed the basis for the development of a hardware and software complex for assessing patients' gait.

S5-1.7 (703) Exploring Maternal-Placental-Fetal Interactions: A Hybrid Modeling Approach for Biomedical Engineering

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Monitoring fetal oxygen delivery during pregnancy, especially labor and delivery, is challenging due to limited real-time data. This paper presents a hybrid model combining agent-based and system dynamics modeling to simulate oxygen delivery from mother to fetus through the placenta. The model's potential applications are explored in two areas: as a tool for clinical decision support by simulating patient-specific scenarios to predict and manage fetal oxygen levels and as an educational resource for medical students to understand maternal-placental-fetal physiology. The model, implemented in NetLogo, consists of an agent-based component visualizing blood flow at the placenta and a system dynamics component modeling maternal and fetal cardiovascular systems using ordinary differential equations (ODEs). Scenarios, including normal conditions, maternal anemia, and other pathological states, are simulated to observe their effects on fetal oxygen delivery (F_{DO_2}). Simulations show that changes in parameters such as hemoglobin levels, vascular resistance, and heart rate significantly affect F_{DO_2} . For instance, F_{DO_2} drops below a critical threshold in maternal anemia, highlighting the model's ability to predict potential fetal hypoxia. Additionally, the model captures the impact of uterine contractions and anesthesia on F_{DO_2} , providing insights into dynamic changes during labor or surgical interventions. The model demonstrates promise as a clinical decision-support tool and educational platform. However, limitations include simplified physiological representations and the need for validation with clinical data. This hybrid modeling approach offers a novel way to enhance the understanding and management of fetal oxygen delivery, improving patient care and medical education.

S5-1.8 (726) Towards More Protected Medical Data: Assessing the Security of Web and Email Infrastructures in SMEs in the Republic of Moldova

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The increasing digitalization of the healthcare sector has elevated the urgency of securing the web and email infrastructures used by small and medium-sized enterprises (SMEs). This paper presents the first comprehensive security assessment of 80 medical SME domains and subdomains in the Republic of Moldova. Using a passive OSINT-based methodology and an automated Python tool, the study identified critical misconfigurations, including outdated TLS versions, missing DNSSEC, weak or absent security headers, insecure cookies, and insufficient email authentication mechanisms.

To address these challenges, we propose a Security Compliance Score (SCS) Model designed to quantitatively evaluate the security posture of SMEs. The model incorporates six key parameters—TLS configuration, DNSSEC deployment, secure cookies, security headers, email authentication, and server exposure—each scored and weighted based on technical benchmarks. The model enables comparative analysis and supports engineering decisions on risk prioritization.

Results indicate that only 65% of the analyzed domains had valid TLS configurations, while DNSSEC was virtually absent. Email security remained highly inconsistent, with no DKIM or DMARC configurations on subdomains and frequent use of self-signed certificates. The findings underscore the need for structured remediation and informed security governance.

The proposed SCS model and automated workflow offer a scalable, replicable framework for evaluating web security in medical environments, which can be extended to other national or regional contexts.

S5-1.9 (779) Artificial Intelligence in Healthcare: Real-World Integration, Cybersecurity Risks and Challenges

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Advancements in artificial intelligence (AI) continue to drive innovation across industry, society, and the economy, including the healthcare sector. Since the initial adoption of AI technologies, healthcare providers have increasingly integrated these tools to enhance accuracy, efficiency, and decision support in diagnosis, treatment, and individualized patient care workflows. Applications such as medical imaging analysis, early disease detection, and administrative optimization have moved from trials into real-world deployments, offering valuable insights into both the benefits and emerging risks of AI in clinical settings. This paper expands on a previous study and presents an updated assessment of AI integration in healthcare, with a specific focus on cybersecurity risks and real-world developments since 2023. Using a selective literature review combined with examination of recent deployments and evolving regulatory frameworks, the paper discusses how foundational cybersecurity vulnerabilities, already present in healthcare infrastructure, are intensified by AI-specific challenges, including data governance weaknesses, model trustworthiness, and the risk of biased or manipulated outputs. The research also highlights how uneven regulatory landscapes across countries create inconsistencies in AI oversight, increasing exposure to cyber threats. Identified examples, such as the integration of AI in radiology, illustrate how these trends manifest in practice. Building on these findings, the paper discusses the current progress in ensuring a secure AI adoption in healthcare and outlines recommendations to mitigate these complex risks and promote safe, ethical, and effective use.

S5-P44 (806) Non-Invasive Monitoring of Desaturation Events in Stroke Patients

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Ischemic stroke remains a major cause of mortality and long-term disability worldwide. Effective early management is essential to prevent further neurological damage and support recovery. Hypoxia, particularly during the acute phase, is often underestimated, despite the brain's heightened vulnerability to oxygen deprivation. Monitoring arterial oxygen saturation (SaO₂) is therefore critical. This study examined the impact of desaturation events within the first 24 hours of hospital admission using non-invasive pulse oximetry. Data were analyzed from a cohort of 556 patients diagnosed with acute ischemic stroke or transient ischemic attack (TIA) within 7 days of symptom onset, between November 2024 and March 2025. Of these, 323 patients admitted to the stroke unit during the first night of hospitalization were included. SaO₂ levels of 96–97% were associated with more favorable functional outcomes, while desaturation episodes (SaO₂ <93%) correlated with higher rates of severe complications and a greater frequency of wake-up stroke (WUS). Continuous monitoring was performed using a portable pulse oximeter, which recorded oxygen saturation and heart rate. The device was set to alarm when SpO₂ dropped below a predefined threshold or when heart rate increased by more than 6 beats per minute for at least 8 seconds. Pulse oximetry proved to be a sensitive and practical method for identifying hypoxia and high-risk patients. These findings support the integration of continuous pulse oximetry into standard stroke care, offering opportunities for timely intervention and improved patient outcomes.

SECTION S6

Bioengineering in oral health

S6-1.1 (740) Assessment of Anatomical Balance Alterations Following Orthognathic Surgery Based on the FAB Concept

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Historically, the origin of the term orthognathic surgery which initially referred solely to surgical procedures involving the mandible can be traced back to the mid-19th century in the United States. This historical evolution laid the groundwork for the integration of orthognathic surgery into multidisciplinary treatment protocols, linking skeletal correction with dental alignment and, later, with facial aesthetics and airway functionality. Furthermore, computer-aided design and manufacturing (CAD/CAM) technologies now enable the fabrication of custom surgical guides, osteotomy splints, and patient-specific fixation plates, significantly increasing intraoperative accuracy and reducing operative time. In this study, virtual surgical planning was used to evaluate and calculate the volume of specific anatomical structures of interest in a group of 20 patients. The patients were divided into 2 study groups based on the type of dento-maxillary anomaly. Anatomical structures were evaluated before surgery and at 4 weeks postoperative. The results obtained provide valuable insight into the volumetric evolution of the oral cavity among the patients included in the study. On average, the oral cavity volume increased by 10.8% in Class II patients and 6.1% in Class III patients. Considering the limitations of the present study, it can be concluded that, contrary to initial hypotheses, anatomical balance underwent statistically significant changes, characterized by a decrease in values across both patient groups.

S6-1.2 (741) Assessment of Anatomical Balance in Dento-Facial Anomalies Using Virtual Surgical Planning

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Dento-maxillary anomalies are defined as growth and developmental disorders of the dental arches, jaws, as well as facial soft tissues. Most studies highlight the significance of combining orthodontic treatment with orthognathic surgery, as it remains the only widely used approach worldwide that enables the correction of these anomalies through surgical interventions on the dental arches and/or maxillary bones, leading to a substantial improvement in quality of life. Virtual surgical planning offers the capability to simulate a wide range of surgical techniques, providing a more precise and predictable approach to treatment. The anatomical balance of the oral cavity refers to the harmonious relationship among the various anatomical structures that comprise the stomatognathic system. In this study, virtual surgical planning was used to evaluate and calculate the volume of specific anatomical structures of interest in a group of 90 patients. The patients were divided into 3 study groups based on the type of dento-maxillary anomaly. In total, 28 males and 62 females were included in this study, with an average age of 28.13 years). Given the observed differences in oral cavity volume, with Class III patients exhibiting a larger volume and Class II patients a smaller one, while anatomic balance remains stable across all groups, it is plausible that this reflects an adaptive compensatory mechanism of the body. Considering the limitations of the current study, the findings suggest that, contrary to the general belief, anatomic balance is not directly influenced by the dento-maxillary anomalies.

S6-1.3 (745) Influence of *Streptococcus Mutans* on the Level of Immune System Biomarkers in Oral Fluid in Children

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The aim was to investigate the influence of *Streptococcus mutans* on the level of immune system biomarkers in oral fluid in children for further development of highly accurate prediction methods for dental caries. 398 children were examined, aged between 3 and 15 years, who were divided into two groups. The research group (L_1) 132 children with caries lesions and 266 caries-free children formed the control group (L_0). The number of *Streptococcus mutans*, the level of tumor necrosis factor alpha (TNF- α), transforming growth factor beta-1 (TGF- β 1), secretory immunoglobulin A (sIgA) and antimicrobial peptide (cathelicidin LL-37) were estimated in oral fluid (OF). The positive test result determined the increased number of *Streptococcus mutans* in OF of $>5 \times 10^5$ CFU/mL was estimated at 53.0%, $p < 0.001$ of children in L_1 and 8.6% of subjects in L_0 , which indicates an increased risk of developing carious lesions in the future. The low number of *Streptococcus mutans* in OF of $<5 \times 10^5$ CFU/mL was appreciated and the patient does not show a risk of developing carious lesions in the future.

Children with increased numbers of *Streptococcus mutans* in the OF ($>5 \times 10^5$ CFU/mL) were found to have statistically significant increases in the number of demineralized areas of tooth enamel, compared to subjects with low numbers of *Streptococcus mutans* in the OF ($<5 \times 10^5$ CFU/mL). The comparative study of immune system biomarkers showed deficient level of salivary protective factors: sIgA, LL-37 and TGF- β 1 and significantly increased level of TNF- α in children with high number of *Streptococcus mutans*.

S6-1.4 (747) Level of Immunoregulatory Molecules and Vitamin D3 in Oral Fluid in Children with Carious Lesions

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The aim of the study was to estimate the relationship between vitamin D₃ (25(OH)D₃) levels and oral cavity immunity parameters (secretory immunoglobulin A - sIgA, antimicrobial peptide LL-37 and transforming growth factor beta-1 (TGF- β 1) in oral fluid in children with dental caries, for further development of non-invasive methods for prediction of DC. Were studied the levels of 25(OH)D₃, sIgA, TGF- β 1 LL-37 in oral fluid (OF) in a sample of 398 conventionally healthy children aged 3-15 years who were divided into two groups. The research group (L_1) consisted of 132 children with carious lesions and 266 children without caries formed the control group (L_0). The results obtained from clinical examination and DC prediction were confirmed by salivary biomarker complex study. In carioreceptive children, direct links were found between the OF content of 25(OH)D₃ and the levels of LL-37 peptide, sIgA and TGF- β 1, where was determined a lower level in children affected by dental caries. Conclusions: the combined assessment of 25(OH)D₃, sIgA, TGF- β 1 and LL-37 biomarkers in OF represents a non-invasive and innovative assay for DC prognosis with higher sensitivity and specificity and identification of subjects at increased risk of rapid, aggressive progression of the caries process. At the same time, for clinical use of OF biomarkers, it is necessary to develop standardized protocols and perform large studies in which the influence of different confounding variables is excluded.

S6-1.5 (749) Structural and Chemical Peculiarities of Tooth Enamel in Prematurely Born Children

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The aim of the present study was to elucidate the structural and chemical peculiarities of dental enamel in prematurely born children. A case-control clinical study was conducted on a sample of 978 children aged 1 to 15 years, divided into two proportional groups based on enamel structure. The research group L₁ consisted of 326 prematurely born children (according to anamnesis data), and the control group L₀ included 652 conventionally healthy children. The prevalence indices of dental caries (DC) were assessed. The structure and chemical composition of enamel samples obtained from teeth extracted for medical reasons were analyzed. Scanning electron microscopy (SEM), radiospectral microanalysis (RSMA) using energy-dispersive X-ray spectroscopy (EDX) with a material-type detector, and Atomic Force Microscopy (AFM) were performed. SEM and AFM investigations revealed the following structural and chemical features of dental enamel in prematurely born children: an increased proportion of organic components in relative to mineral components; the presence of areas with numerous pores and disorganization of structural elements on the enamel surface; and a decreased mass percentage of P, Ca, Cl, Mg and Na. Conclusions. The structural and chemical features of dental enamel identified at both molecular and macroscopic levels in prematurely born children indicate an increased risk of developing DC. These findings support the need for the implementation of effective preventive measures.

S6-1.6 (750) Crystallization Potential of Oral Fluid in Preterm Children

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The aim of the study was to elucidate the crystallization potential of oral fluid in preterm children. A case-control clinical study was conducted on a sample of 978 children aged 1 to 15 years, divided into 2 proportionally structured groups. The research group L₁ consisted of 326 preterm children (according to anamnesis data), and the control group L₀ consisted of 652 conventionally healthy children. The prevalence index of dental caries (DC) was assessed. The potential for oral fluid crystallization (OFC) was analyzed. Dehydration of oral fluid (OF) droplets was carried out in a unit at t=37°C, protected from dust. Micropreparations were examined under AmScope B120C-E1 Binocular Compound Microscope. The oral fluid crystallization potential (OFCP) in preterm children was low, measuring 1.89±1.29 points, p<0.001, in contrast to the high OFCP (OFCP=3.67±0.34) observed in conventionally healthy subjects. The OFCP in children from group L₁ was 1.94 times lower than that in subjects from group L₀. Conclusions: The decrease in OFCP represents an important etiological factor in the increased susceptibility to DC, particularly during the period of post-eruptive tooth mineralization. The identification of crystallographic features through the evaluation of OFCP offers a complementary diagnostic tool of practical value to predict DC. This approach enables the identification of individuals at higher risk for dental caries and provides an opportunity to select effective, personalized, and early preventive strategies.

S6-1.7 (825) Aesthetic Perception of Dental Fluorosis and Quality of Life Related to Oral Health

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Dental fluorosis alters the appearance of tooth enamel, with severity dependent on factors such as exposure time and type of intake (ingested vs. inhaled), weight, physical activity, nutrition, bone growth and metabolic function. Optimal fluoride dosage ranges from 0.05-0.07mg F/Kg body weight. Various indices describe the clinical manifestations of dental fluorosis, which is also a cosmetic concern in addition to functional restoration. Patients desire an attractive smile, leading to treatment options such as bleaching, enamel *microabrasions*, and veneers. Several reports have analyzed the social implications of dental fluorosis and identified a correlation between its clinical manifestation and mental well-being. The social norm mandates beautiful teeth and when it deviates from that there are greater risks of social rejection and ridicule. Recent studies have focused on assessing the severity of dental fluorosis and its impact on an individual's quality of life and society. Further investigations have led to the development of a strategy to evaluate dental fluorosis' effect on daily life, known as OHRQoL. Dental fluorosis can significantly impact a person's OHRQoL by damaging their self-esteem and hindering their ability to perform daily activities such as eating, speaking, and smiling, as well as activities of daily living such as work, school, and family interactions. There are various standardized questionnaires or scales used to measure OHRQ. Over time, researchers have developed quality of life instruments specifically tailored to oral health, and the number of these instruments continues to increase rapidly to meet the need for more specific measures.

S6-1.8 (832) Healthy Diet as a Preventive Factor for Dental Caries in Children across the European Union: A Comparative Analysis and Best Practices

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This study explores the relationship between healthy eating habits and the prevention of dental caries among children in the European Union. Drawing on statistical data from the WHO, Eurostat, and national health reports, a comparative analysis is conducted to evaluate the prevalence of dental caries in relation to nutrition policies, educational interventions, and access to dental care services. Case studies from Romania, Sweden, France, Germany, and Spain are examined to highlight best practices in caries prevention, including school-based health programs, fiscal regulations that promote healthier food choices, and community-level initiatives that engage families and local institutions. The findings underscore the importance of integrated public policies that combine nutrition education, health-oriented taxation, free and equitable access to dental services, and strong involvement from local governments and stakeholders. Romania demonstrates significant potential for improvement through the expansion of current programs and the development of a consistent and effective legislative framework. The study proposes a transferable intervention model that can be adapted and implemented across EU member states, along with tailored policy recommendations specifically designed for the Romanian context. Ultimately, the research highlights the importance of collaborative efforts among the health, education, and policy sectors to address oral health disparities and develop long-term, sustainable prevention strategies for children across Europe.

SECTION S7

Regenerative medicine and tissue engineering

S7-1.1 (732) Controlled Release of Bioactive Agents from Demineralized Bone Using Sequential Double Vacuum Loading

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The performed research explores the use of consecutive vacuum loading to control the release of biologically active substances from demineralized cancellous bone (DCB), using methylene blue (MB) as a model substance and bovine serum albumin (BSA) as a secondary coating/diffusion layer. This method aims to enhance the utility of DCBs in regenerative medicine by improving the delivery and controlled release of therapeutic agents. During the study two vacuum conditions were tested – loading the DCBs with MB at low vacuum (LV, 400 mbar) and high vacuum (HV, 100 mbar), and examining their impact on MB loading and release. Results showed that HV allowed deeper and more uniform MB penetration, resulting in a more sustained release profile. In contrast, low vacuum caused a faster initial release due to more superficial loading. Secondary loading with 10 % and 20% BSA further modulated release dynamics. BSA coatings slowed initial MB diffusion but eventually supported higher sustained release especially for the group loaded under HV conditions. This effect is likely due to the film-forming and drug-binding properties of BSA, which may prevent early MB washout and enhance matrix interaction.

We concluded that vacuum level and sequential loading significantly influence release behavior and can be harnessed by creating the advanced, customizable bone grafts with highly tunable release capability over a long time. These findings have important implications for designing multifunctional grafts tailored to specific therapeutic needs using tissue engineering methods.

S7-1.2 (738) Assessment of Biocompatibility of a Large-Diameter Vascular Decellularized Xenograft

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Cardiovascular diseases (CVDs) remain one of the most prevalent healthcare problems worldwide, with the ageing of the population causing a significant increase in CVD-related mortalities. Treatment of this group of patients may require a multilateral approach, including pharmaceutical correction, endovascular technologies, and invasive bypass surgeries in patients with severe symptoms. During a bypass surgery, a vascular substitute, or graft, is used to create a new pathway for blood flow, allowing for the restoration of the functional blood supply. Lack of optimal vascular grafts has necessitated evaluating the utility of tissue-engineering methods for the development of new functional surgical conduits, which possess the most physiological properties and exhibit excellent patency. These “ideal” cardiovascular bypass grafts should fit a range of characteristics, including biocompatibility, non-immunogenicity, easy handling, mechanical resistance and compliance, ability to grow, remodel, and self-repair after implantation.

Decellularized vascular scaffolds seem to be an attractive therapeutic solution; however, the efficiency of the decellularization (DC) process and the quality of the obtained matrices are dependent on a range of factors. Cytotoxicity of the vascular graft obtained by DC is induced by the presence of DC agents' residue in the matrix. Identification of the conditions allowing the chemicals' optimal removal, including the demand to perform repeating washing steps, is mandatory before *in vivo* evaluation and clinical application.

S7-1.3 (811) In Vitro Evaluation of Biocompatibility of Collagen Sponges Extracted from the Human Umbilical-Placental Complex for Biomedical Applications

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The paper presents an in vitro study on the evaluation of the biocompatibility of collagen sponges extracted from the human umbilical-placental complex, with a view to their use in medical applications. Collagen, being a major structural protein of the human body, which is found especially in bone tissue in a proportion of approximately 30%, has a high applicability in bone regeneration. Bone grafting based on collagen from autologous sources is limited, and xenogeneic sources pose a risk of transmitting zoonoses, thus the use of collagen from the umbilical-placental complex would be of interest for safe use in regeneration. In this study, collagen was obtained by a modified enzymatic method, and some samples were purified using surfactants such as SDS 0.1%, SDC 1% and EDTA 1%. Samples were transformed into collagen sponges, sterilized and subjected to biocompatibility tests: MTT test (for cell viability) at 24, 48 and 72 hours and cell adhesion test at 7 and 14 days, using bone cell cultures. Results indicated good cell viability (over 80%) and high cell adhesion, with an increased cell density over time and the comparison between purified and non-purified samples, suggesting that the use of surfactants does not negatively affect the biocompatibility of collagen. Overall conclusion is that collagen sponges extracted from human placenta and umbilical cord can be considered safe and effective biomaterials for medical applications, especially in oral and maxillofacial tissue reconstruction.

S7-1.4 (828) Bioactive Cardiac Patches Based on Poly(HEMA) and Biopolymers

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The present study aimed the obtaining of some materials with potential applications in the development of cardiac patches. In this context, the developed hydrogels must present appropriate properties of myocardial tissue to ensure adequate compatibility and functionality. For their development, were involved synthetic polymers based on 2-hydroxyethyl methacrylate, acrylamide, bis-acrylamide, whose mechanical properties are higher compared to those of natural ones. Also, poly(N-isopropylacrylamide), a temperature-sensitive polymer, was used in order to obtain materials that exhibits improved bioadhesive properties at the contact with the human body (37°C, physiological conditions). In order to increase biocompatibility, fibrillar collagen was used as a natural polymeric filler.

The aim of this study was to investigate the effects induced on materials by incorporating structurally modified gelatin, and oxidized alginate. The obtained materials were subsequently characterized to evaluate their biological fluids retention capacity, morphological characteristics, mechanical properties, bioadhesive properties, loading and controlled releasing efficiency of the active substance, cytocompatibility and biodegradability.

S7-1.5 (829) 3D Printed Gelatin and Xanthan-Based Architectures for Soft Tissue Engineering

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Among the current 3D (bio)printing techniques (inkjet, extrusion, laser), extrusion is distinguished by its affordability and its capability to produce biomimetic structures. The fabrication of (bio)printed scaffolds with advantageous characteristics needs biocompatible (bio)inks, tailored to the particular application. This study aims to generate inks based on gelatin and xanthan (in various ratios), 3D printing and tests as scaffolds for skin tissue engineering. The printed polymer scaffolds were examined for their morphological properties by stereoscopic microscopy, chemical structure (FT-IR analysis) and were further assessed in terms of retention capacity for simulated biological fluids, enzymatic degradation, and cytotoxicity. The trials conducted needed enhancements of the mechanical properties. In this context, polymers chemically altered by the methacrylation reaction (GelMA and XGMA) were employed, utilizing LAP as a photocrosslinking initiator and riboflavin as a crosslinking agent. After conducting swelling and degradation experiments, it was determined that materials produced through double crosslinking exhibit superior qualities compared to those derived from gelatin and xanthan. Also, the bioadhesive properties were improved through the polymers methacrylation reaction, due to a better interaction between the polymers. The scaffold's interaction with the cells confirmed their compatibility, the cells preserving the characteristic morphology, indicating their potential application in soft tissue engineering.

S7-P45 (757) Evaluation of the Regenerative Efficacy of Biological Dressings Developed Through Tissue Engineering

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Recent advances in tissue engineering and regenerative medicine have developed innovative methods in skin regeneration, in skin wounds, where standard approaches are limited. The aim of the study is to explore the integration of active biological dressings developed through tissue engineering and their role in the regeneration of skin defects. By using the engineering methods, we developed the biocompatible, biodegradable non-toxic porous biomaterials with regenerative properties from pig. In the preclinical study, Wistar rats (n=24) were used, divided into 3 experimental groups (n=8): 1. saline solution (NaCl 0.9%); 2. sponge from acellular porcine dermis with Gentamicin and 3. collagen sponge from the submucosa of the porcine small intestine combined with 0.01% Povidone-iodine solution. We followed the regenerative efficacy of the biological dressings developed by tissue engineering. We monitored wound closure by skin contraction at 0, 4, 7, 14, 21 days. This was estimated as the percentage reduction in the initial wound diameter (measured as the distance between each wound edge, the wound edges being identified by the appearance of hair follicles and collagen in the dermis). The biological dressings developed from dermal collagen sponge, from the submucosa of the porcine small intestine showed complete wound closure by keratinized stratified epithelium, as well as the presence of a scar formed in the dermis at 21 days. Due to the combined regenerative, antibacterial and antifungal properties, biomaterials developed by tissue engineering will be able to be transformed into bio-dressings for wound healing.

S7-P46 (768) Future Trends for Corneal Implants, Keratoplasty Solutions

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Currently, it is estimated that 10 million patients diagnosed with bilateral corneal blindness suffer from corneal diseases worldwide. Eye Bank Associations show that corneal transplantation is highly successful in low-risk patients with corneal blindness, but often fails in those with high-risk indications, such as recurrent or chronic inflammatory disorders, a history of glaucoma and herpetic infections, and those with neovascularization of the host bed. Therefore, artificial and biomimetic corneas have been investigated for patients with indications that lead to keratoplasty failure. Certain biomolecules, such as collagen, can be used as a basis for bio-inks in 3D corneal bioprinting. Alternatively, xenogeneic decellularized corneas have shown potential in preserving the fibrillar architecture. This review discusses the possibility of broadening the spectrum of corneal transplantation with the future use of synthetic keratoprotheses and the limits of keratoplasty in the Republic of Moldova. In recent years, advancements in tissue engineering and regenerative medicine have provided innovative solutions for restoring corneal function. These include decellularized xenografts, bioengineered collagen scaffolds, and advanced preservation techniques that aim to maintain tissue viability and integrity. Research efforts are increasingly focused on improving biointegration, minimizing immune rejection, and enhancing optical clarity. Moreover, emerging technologies such as stem cell therapy and nanomaterials offer new perspectives in corneal repair and regeneration. The integration of these novel approaches may revolutionize treatment for corneal blindness and expand access to effective care, particularly in countries with limited donor tissue availability.

S7-P47 (827) Bioactive Propolis-Loaded Hydrogels for Enhanced Diabetic Foot Wound Healing

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Chronic lower limb ulcers, especially those linked to diabetes mellitus, are serious complications arising from peripheral neuropathy, ischemia, and impaired wound healing. These lesions are among the primary causes of non-traumatic amputations and place a substantial burden on both patients and healthcare systems. Existing treatments are often invasive and associated with a high risk of complications, highlighting the need for effective, non-invasive alternatives that can be applied during early stages of the disease.

This study presents the development of bioactive hydrogels composed of natural biopolymers (sodium alginate and xanthan gum) and propolis extract obtained from raw propolis, which was collected in the spring of 2024 from *Apis mellifera* hives. The hydrogels were designed as dressings for the treatment of diabetic foot ulcers and are aiming to maintain a moist, bioactive environment conducive to tissue regeneration while preventing bacterial infection and inflammation. Propolis, rich in flavonoids, phenolic acids, and terpenes, contributes to antimicrobial, anti-inflammatory, and immunomodulatory effects. These properties support wound healing and may reduce the progression of chronic lesions. By combining the structural benefits of biopolymers with the

therapeutic action of propolis, the proposed formulations are offering a promising strategy for improving outcomes in chronic diabetic wound management. The three-dimensional structures with different composition ratios were assessed for morphology, fluid retention capacity, bioadhesive properties and cytocompatibility. The experimental results allowed us to consider the analyzed hydrogels as potential wound dressings for chronic diabetic ulcer.

SECTION S8

Medical physics & biophysics

S8-1.1 (689) Urodynamic Assessment in Women with Overactive Bladder

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Overactive bladder (OAB) is characterized by the presence of lower urinary tract symptoms such as urgency, nocturia, daytime urinary frequency, with or without urge urinary incontinence. The prevalence of OAB is higher in women (33,7%) than in men (14,6%). Before considering invasive treatments, guidelines recommend urodynamics to identify DO. However, the clinical effectiveness of urodynamics has never been robustly assessed in women. We aimed to compare the clinical effectiveness of urodynamics at different ages of women with refractory OAB symptoms. In 72 patients with OAB enrolled in the study, data were collected through UDS. The patients were analyzed by age group – reproductive age (RP, n = 49) and climacteric period (CP, n = 27) and duration since the onset of the disease (≤ 6 / >6 months). In women with OAB in the CP, there was a general trend of lower mean values for urodynamic indices, with statistical significance for the following parameters: $p < 0.001$ – urinary index, strong urge to void; $p < 0.01$ – first sensation of void, water sample, estimated isovolumetric pressure – modified. In the group of women with OAB lasting >6 months after the onset of the disease, was established statistically significantly lower mean values for the urodynamic indices, which reveals a potential association between the more severe values of the paraclinical indices and longer duration since the onset of the disease. The results suggest that the urodynamic parameters are consistent and show differential associations with the age factor of women with OAB and the duration from disease onset factor.

S8-1.2 (808) Nonlinear Dynamics of Cell Migration between Two Cancer Centers

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A theoretical model explaining the evolution of two cancer centers through the concentration of T-lymphocytes is presented. The model explores how variations in T-lymphocyte parameters and cellular diffusion rates affect the system's dynamics. It also investigates the conditions under which the system transitions from continuous wave evolution to periodic oscillations and chaotic regimes. Depending on certain parameter values, the system can exhibit a variety of dynamic behaviors: continue waves that manifest a stable equilibrium of the system; periodic and quasi-periodic oscillations, and finally chaotic regimes in which the system becomes unpredictable. The considered model indicates that cell migration between tumors may have a significant impact on disease progression and immune response, e.g., chaotic behavior may reflect increased variability in disease progression, which could complicate therapeutic strategies. Understanding of this dynamic behavior of cells may contribute to the development of more effective approaches to cancer treatment, taking into account the complex interactions between multiple tumor locals and the immune system. These findings shed light on the intricate behavior of immune-tumor interactions and could lead to more effective cancer treatment strategies. In conclusion, the cancer progression can be predicted by the mathematical modeling of metastasis and good therapeutically strategies and targeting cell migration can be achieved.

S8-1.3 (734) Numerical and Experimental Investigation of Cylindrical Shrapnel Penetration into Non-Biological Soft Tissue Simulant (Ballistic Plasticine)

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This study investigates the penetration behavior of a cylindrical shrapnel fragment (10 mm in diameter and 10 mm in length) into a non-biological soft tissue simulant—ballistic plasticine. A combination of finite element simulations and ballistic experiments was employed to analyze the penetration dynamics under varying initial velocities, ranging from 50 m/s to 1000 m/s. The experimental phase involved controlled ballistic testing, with shrapnel fragments launched at calibrated speeds to replicate realistic impact scenarios. The computational modeling utilized advanced constitutive formulations for the plasticine, including the Cowper–Symonds viscoplastic model and linear shock wave approximations, which were calibrated and refined based on experimental outcomes. Comparative analysis of the experimental and numerical results enabled the identification and adjustment of material parameters, resulting in strong agreement between simulated and observed penetration depths and wound profiles. Additionally, the influence of the initial shrapnel velocity on wound channel morphology was quantified, with specific focus on penetration depth and wound diameter. Importantly, the study highlights the distribution of pressure waves throughout the surrounding medium, which contributes to widespread material damage beyond the immediate impact zone. These findings are particularly relevant for medical and forensic applications, as they provide insight into trauma mechanisms associated with high-velocity penetrating injuries and support the development of improved protective and treatment strategies.

S8-1.4 (766) Influence of UVC Radiation on Specific Regions of the SARS-CoV-2 Coronavirus Genome that Encode the Synthesis of Structural Proteins

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To study the effect of bactericidal ultraviolet radiation on the SARS-CoV-2 viruses that cause COVID-19, the effects of ultraviolet radiation on the structural components of the viruses were investigated. To inactivate the SARS-CoV-2 viruses, we used light emitting diodes (LED) with maximum radiation at a wavelength of 255 ± 5 nm. All sources of bactericidal ultraviolet radiation have a maximum emissivity close to the maximum of the absorption spectrum of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), and can be used as the basis for devices and treatment methods that prevent the spread of infection and provide additional protection of the health and life of medical personnel working in the infected area ("red" zone).

We conducted two series of experiments with irradiation of infected biomaterial. The biomaterial that was exposed to radiation was selected during Polymerase Chain Reaction (PCR) testing of the population and contained the SARS-CoV-2 virus. In the first series of experiments, the material formed flat droplets with a multi-layered viral medium. Strong absorption of radiation in the droplet material leads to a weakening of the effect on the virus in the deep layers of the

substrate, and a significant increase in the radiation dose is required for effective inactivation of the virus. The second series of studies was carried out on homogeneous thin samples simulating an infected surface with an almost single-layer distribution of the virus.

As a result, it turned out that ultraviolet (UV) radiation at wavelength 255 nm at power densities above 4 mW/cm² effectively suppresses the virus in a practical time. This makes it possible to develop and apply a wide range of sanitation devices containing various types of radiators with a wavelength of 255 nm to combat COVID.

S8-P48 (754) Ultrasound Assessment of Subcutaneous Adipose Tissue as a Predictor of Cardiometabolic Risk in Young Women

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Accurate evaluation of body fat distribution is important for identifying individuals at increased cardiometabolic risk. Ultrasound has gained recognition as a practical method for assessing subcutaneous adipose tissue (SAT), offering enhanced insight into fat patterning. This study aimed to investigate the association between ultrasound measured SAT thickness and cardiometabolic risk factors in young women with obesity.

Material and Methods. Fifty-eight healthy women aged 18–45 years, classified as obese (BMI ≥ 30 kg/m², $n = 27$) or normal weight (BMI ≤ 25 kg/m², $n = 31$), were included in the study. SAT thickness was measured by B-mode ultrasound at nine anatomical sites. Anthropometric indices, blood pressure, fasting glucose, insulin, and lipid profile were assessed.

Results. Women with obesity exhibited significantly greater SAT thickness (13.23 ± 3.5 mm vs. 3.76 ± 0.78 mm, $p < 0.001$), which correlated strongly with anthropometric measures ($r > 0.90$, $p < 0.001$) and was independently associated with BMI ($\beta = 1.35$), waist circumference ($\beta = 3.44$), systolic blood pressure ($\beta = 0.92$), HOMA-IR ($\beta = 0.15$), LDL-cholesterol ($\beta = 0.09$), and the apolipoprotein B/A1 ratio ($\beta = 0.02$) (all $p < 0.001$).

Conclusion. Ultrasound-measured SAT thickness is significantly associated with multiple cardiometabolic risk factors in young women and may serve as a practical, non-invasive tool for early identification of individuals at increased cardiometabolic risk.

S8-P49 (772) Biomedical Engineering as a Subject of Study and Promotion in the Educational Market of Moldova: Research Results

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In the paper highlights the features of the introduction of a new curriculum in the educational market of Moldova - Biomedical Engineering. The importance of training specialists in the field of Biomedical Engineering for the national economy of the country is reflected. The article provides an overview of the main points of the development of biomedicine in the country. The situation in the country's educational services market in the field of Biomedicine is described, the influence of various factors of the marketing environment on the development of this area in Moldova is highlighted. The Technical University of Moldova uses marketing tools to actively promote its study programs among applicants. However, promoting the innovative study program in Biomedical Engineering requires a special approach. Based on a questionnaire survey of students of the Biomedical Engineering program, conducted in March - April 2025, the respondents' awareness and satisfaction with the provision of this educational service were identified. The results of the study reflected in the article demonstrate insufficient awareness of students about the new curriculum, the need for more active promotion. Respondents suggested optimizing cooperation with medical institutions, introducing more practical classes, and involving students in research. The use of a promotion mix, including Internet marketing tools, is becoming an important component of the university promotion program. Promotion planning, development of a promotion strategy in the modern educational market is becoming the most important function of university management.

SECTION S9

Interdisciplinary research for medicine

S9-1.1 (694) Abdominal Non-Hodgkin's Lymphoma in Children

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This study examines the clinical and biochemical characteristics of abdominal non-Hodgkin's lymphoma (NHL) in children, based on 17 cases managed at the Natalia Gheorghiu National Scientific and Practical Center of Pediatric Surgery. Non-Hodgkin's lymphomas in children are aggressive malignancies often located in the abdomen, with symptoms such as abdominal pain, bloating, and intestinal obstruction. Most affected patients were boys from rural areas, aged between 5 and 10 years. Diagnosis relied on a combination of clinical evaluation, imaging (ultrasound, CT, MRI), and laboratory markers (e.g., TNF- α , LDH, ferritin), with significant variations observed in protein metabolism, cytokine profiles (TNF- α , IL-4), and endotoxemic markers (MMM, SN). While TNF- α showed persistently elevated levels across all stages, IL-4 remained within normal limits. Surgery was required in all cases, often involving intestinal or omental resections. Postoperative biochemical fluctuations reflected tumor burden and systemic inflammatory response. The study underscores the importance of early imaging and biomarker analysis for timely diagnosis and intervention. Despite its aggressive nature, abdominal NHL in children responds well to combined surgical and chemotherapeutic approaches, though prognosis may vary with age, immunological status, and tumor subtype. The findings reinforce the necessity for heightened clinical vigilance in pediatric patients presenting with acute abdominal symptoms to prevent delayed diagnosis and complications such as tumor lysis syndrome.

S9-1.2 (702) Comparative Evaluation of K-Anonymity, Differential Privacy, and Pseudonymization for Data Protection in Rare Disease Registries

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Protecting patient confidentiality in rare disease research presents unique challenges due to small population sizes and the increased risk of re-identification through quasi-identifiers. This study presents a comparative evaluation of three anonymization techniques — k-anonymity, differential privacy, and pseudonymization — applied to a fully synthetic dataset of 10,000 rare disease patients, calibrated using real epidemiological distributions. Each method was assessed across three dimensions: confidentiality protection (residual risk, NCP, AECS, ϵ - δ guarantee), analytical utility (impact on descriptive statistics and logistic regression AUC), and computational efficiency (execution time, RAM usage).

The results show that differential privacy ($\epsilon=1.0$) achieved the lowest re-identification risk ($<0.1\%$) with a negligible loss of utility ($\Delta\text{AUC} \approx 0$), making it suitable for open data dissemination. K-anonymity ($k=5$) reduced risk to 2% while introducing moderate information loss ($\text{NCP} \approx 0.12$), offering a compromise where interpretability is prioritized. Pseudonymization preserved full analytical utility and minimal processing cost, but remained insufficient under GDPR due to the potential for re-linkage.

A hybrid anonymization framework is proposed: pseudonymization for internal operations and longitudinal tracking, k-anonymity for interpretable analysis, and differential privacy for public dissemination. This integrated approach ensures compliance with GDPR while preserving analytical usability in rare disease research.

S9-1.3 (744) Medical University Biobank: Advancing Sustainable National and Global Research

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The Medical University Biobank (MUB) in Moldova is a pioneering effort to establish a standardized, sustainable biomedical research infrastructure in a non-EU, pre-accession country. Aligned with ISO 20387 and inspired by BBMRI-ERIC, the Medical University Biobank strengthens Moldova's national biobanking framework through phased implementation, emphasizing infrastructure modernization, comprehensive workforce training, digital transformation, and proactive stakeholder engagement. The Biobank Management System enables real-time sample tracking and GDPR-compliant data management, while AI-driven tools for biospecimen classification enhance research efficiency and ethical compliance.

Despite significant progress, challenges persist, including limited access to European research networks, fragmented regulatory oversight, underdeveloped ethical governance, insufficient data protection systems, and funding constraints.

This paper examines Moldova's biobanking landscape, highlighting the Medical University Biobank's adherence to international standards as a replicable model for resource-constrained settings.

Through its pivotal role in shaping the 2024 National Biobanking Law and collaboration with the Ministry of Health, the MUB drives policy reform, improves research quality, and fosters cross-border collaboration. By aligning with European biobanking ecosystems, the Medical University Biobank advances global biomedical research and public health, offering a scalable, innovative framework for transitioning nations to develop robust, interoperable biobanking systems that support scientific advancement and health outcomes.

S9-1.4 (798) Integrating Sensor Nodes into a Wireless Sensor Node Network

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The work aims to continue previous studies on the integrated sensor network with the aim of developing, assembling and testing a prototype of a wireless sensor network (WNS) and, in particular, the network configuration stage for integrating the developed sensor node into the WNS. Solutions to the problems encountered during implementation are proposed. One of them is to ensure the safety and normal operation of the electronic part of the unit during the operation of the sensor. As an example, a sensor based on films formed by interconnected columnar grains of ZnO:Eu, characterized with good results in gas and UV detection, was integrated and tested under UV light. Testing of this sensor in the WSN node shows fast response and recovery times. The network configuration and connection of its elements were performed, explaining the purpose of each element and their interaction. The solution denotes the possibility of creating a system compatible with any necessary electronic nodes to be added to the network. This takes into account the possibility of attaching any node to the network during its operation without any complex modifications. The results obtained allow significant progress in the further development of the topic and conduct further research in a more comprehensive manner.

S9-1.5 (815) Development of a Smart Platform for Managing Medical Inventory

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Inventory management continues to be a major challenge for small businesses and resource-constrained institutions, particularly in sectors like healthcare, where manual processes lead to critical errors, stockouts, and operational inefficiencies. To address these issues, in this work, we have developed a Smart Inventory Platform with 1D/2D Scanner, designed to automate and optimize inventory management using advanced hardware and software solutions. The platform combines a portable mini-scanner built on an ESP8266 microcontroller and GM65 barcode module which supports both 1D/2D barcode and QR code scanning. This is complemented by a Raspberry Pi 5-powered mini-terminal, a dedicated mobile application, and a modular web-based platform. The platform enables real-time inventory tracking and centralized data management through a custom-built Content Management System. Key features include role-based access control, real-time stock updates, expiry alerts, inventory analytics, and the ability to export data in multiple formats. These functionalities are accessible via an intuitive and user-friendly interface, designed to streamline stock handling and reduce human error. The proposed solution offers a scalable and cost-effective alternative to commercial inventory systems, particularly for institutions with limited technical or financial resources. By digitizing inventory operations, the platform enhances transparency, improves decision-making, and supports better resource allocation.

S9-1.6 (820) Modular Mobile Robotic Platform for Smart City and Indoor Service Applications

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This paper presents the design, integration, and validation of ProSSSy-IV, a modular mobile robotic platform developed for service robotics applications in Smart City and healthcare environments. From a systems engineering perspective, the platform adopts a layered architectural approach that clearly separates mechanical actuation, embedded control, and environmental sensing into three hardware levels. The system incorporates ROS-compatible components, including a Raspberry Pi 4 for high-level integration, an Arduino Mega 2560 for motor actuation, and onboard sensors such as RPLIDAR A1 and MPU-9250 IMU. A comprehensive URDF model was developed using Xacro macros, integrating 15 links and 14 joints, with precise definitions of inertial and visual parameters to ensure accurate spatial correspondence in ROS and RViz. The TF frame hierarchy was fully validated and used as the foundation for sensor fusion and SLAM applications. The platform's behavior was also validated in Gazebo simulation, employing realistic kinematic parameters and velocity controllers. Differential drive models, sensor emulation, and odometry feedback were tested under reproducible conditions, ensuring consistency between simulated and physical performance. By combining modular hardware design, accurate URDF modeling, and realistic simulation workflows, the ProSSSy-IV platform serves as a flexible and reusable testbed for robotics education, prototyping, and deployment in structured indoor environments such as hospitals, laboratories, and smart buildings.

S9-1.7 (821) Embedded Power Management and State-of-charge Estimation in Modular Robotic Platforms: Experimental Validation and Web-based Monitoring

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This paper presents the design, implementation, and validation of a low-cost embedded system for energy management and State-of-Charge estimation in modular mobile robotic platforms. The system integrates voltage, current, and temperature sensors, wireless relay control, and a web-based monitoring dashboard, all managed via an ESP8266 microcontroller. Two SoC estimation methods were experimentally implemented: one based on open-circuit voltage regression using a fifth-degree polynomial model, and another relying on current integration. Experimental validation was performed using both lithium-ion (3S, 2200 mAh) and lead-acid (12 V/7 Ah) batteries, under idle, nominal, and high-load conditions. A comparative error analysis confirmed consistent estimation accuracy, with relative errors remaining below 5% in critical ranges. The system's real-time performance was assessed through stepwise discharge protocols, complemented by asynchronous web visualization and relay switching. The web interface was developed in two versions, resulting in a modular architecture based on the LittleFS file system and dynamic JavaScript rendering. Results confirm the platform's suitability for integration in service robotics, where energy autonomy and transparent system supervision are essential. Due to its low power footprint and flexible structure, the solution is well-suited for smart indoor environments and robotics prototyping logistics, clinical, and Smart City applications.

S9-1.8 (706) Multi-Agent Decision Support for Sepsis: Balancing Precision and Hallucination Risks in Biomedical Engineering

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Sepsis remains a critical challenge in intensive care, demanding rapid and accurate decision-making to optimize patient outcomes. This study evaluates a multi-agent system designed to support sepsis management by integrating three specialized agents—sepsis management, antibiotic recommendation, and guidelines compliance—using retrieval-augmented generation (RAG) to leverage current literature and guidelines. Initially tested on a single pneumonia-related sepsis case from the MIMIC IV database, the system has now been assessed across 10 diverse cases, including eight from MIMIC IV (e.g., necrotizing fasciitis, genitourinary sepsis) and 2 from specialized literature. The evaluation, conducted with Palmyra-Med 70B and compared against GPT-3.5 Turbo and GPT-4o Mini, focuses on recommendation accuracy, guideline adherence, and the prevalence of hallucinations—unsupported or excessive outputs that undermine reliability. Initial results concerning the pneumonia-related sepsis case indicate acceptable recommendations per expert reviews (Cohen's Kappa = 0.622, p = 0.003), with strengths in early antibiotic suggestions and

monitoring strategies. However, with further testing, hallucinations, such as erroneous clinical assertions, were detected across cases, with groundedness scores varying. Programmatic evaluations (e.g., TruLens) and human expert assessments highlight the need for improved context relevance and response grounding. This system exemplifies the potential of multi-agent architectures in clinical decision support for biomedical engineering yet underscores the challenge of ensuring reliability in real-time applications. Addressing hallucinations through refined RAG databases and agent definitions is critical for clinical adoption. This work invites further validation across broader datasets and integration into ICU workflows, offering a pathway to enhance sepsis care through advanced informatics.

S9-P50 (722) Patient Safety Culture in the Primary Health Care Institutions from the Republic of Moldova

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During the provision of primary health care, according to WHO, 4 out of 10 patients are at risk during the provision of primary health care. Unsafe health care is responsible for over 3 million deaths each year. The paper initially assesses various aspects of patient safety within primary health care settings, to identify issues that require further improvements for patient safety during health care services.

In Moldova, a cross-sectional study was conducted based on the MOSPSC questionnaire, using the AHRQ instrument in primary healthcare institutions. The non-probabilistic study sample included 820 family doctors. The Likert scale was used for response. The response rate for the paper survey was 68.5% and for the online survey was 31.5%. General practitioners – 64.3%, rural doctors – 80.6%, and doctors responsible for management represented 18.6%, resident doctors from Chisinau -13.7%. The rate of positive responses with subsequent identification of the critical and developed areas of patient safety culture was found to be 94.6%. The perspectives with the highest values were observed among: Organizational learning (97%), Workplace stress and peace of mind (94%), Processes in the Medical Center and standardization (95%), Traceability of patient care/follow-up (90%) and General perception of patient safety and quality (87%). To identify the problems that need to be solved, it is necessary to assess the access to healthcare, medicines, diagnostic equipment, information exchange and overall assessment of quality and safety.

S9-P51 (735) INS-GPS Simplified Architecture for a Small Quadrotor Platform used in Healthcare Logistics

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This paper presents a simplified INS-GPS (Inertial Navigation System - Global Positioning System) architecture designed for a small quadrotor platform, aimed at optimizing healthcare logistics operations in urban environments. The proposed system integrates data from an onboard Inertial Measurement Unit (IMU), composed of accelerometers and gyroscopes, with GPS signals to provide accurate and stable real-time navigation capabilities. By fusing inertial and satellite data through a lightweight algorithm tailored for low-power embedded systems, the platform ensures continuous position estimation even in scenarios where GPS signals are weak or temporarily lost, such as in dense urban areas or near hospital infrastructures.

The hardware implementation includes a modular IMU-GPS interface integrated with a microcontroller unit, allowing for efficient data acquisition and processing. On the software side, a sensor fusion algorithm based on a complementary filter was developed to correct IMU drift using

GPS updates, achieving a balance between accuracy and computational simplicity. Practical flight tests were conducted to evaluate the performance of the navigation system, with position data collected and compared against theoretical trajectories. The results indicate a significant improvement in positional accuracy when using the fused INS-GPS solution versus standalone GPS or IMU data. The system demonstrates potential for real-world applications in healthcare logistics, such as medical supply delivery and emergency response, where reliability, efficiency, and precision are critical.

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