Drug Delivery Systems and Their Importance in Health

Blended Intensive Programme ID: 2025-1-TR01-KA131-HED-000320753-1

Overview of Dates

Subject	Date
Online lectures	**Monday 06.07.26 - Friday 10.07.26**
In-person lectures	**Monday 13.07.26 - Tuesday 14.07.26**
Case study and workshops	**Wednesday 15.07.26**
Introduction to Assessment Project	**Thursday 16.07.26**
Examination of lectures (online, in-person, workshops, case study)(2 ECTS)	**Thursday 16.07.26**
TechnoPark visit	**Friday 17.07.26**
Social programs	**Sunday 12.07.26, Monday 13.07.26 and Friday 17.07.26**
Online work on assessment projects	**20.07.2026 - 05.08.2026**
Presentations of assessment projects (1 ECTS)	**06.08.2026 - 07.08.2026**

Online Program

06.07.26	07.07.26	08.07.26	09.07.26	10.07.26
9:00 – 9:10 Welcome Session **9:15 – 10:45** Future perspectives on the integration of lipid nanoparticles with AI-driven drug delivery systems (Sebastian Kraszewski)	**9:00 – 10:45** Analytical Approaches to Characterize Drug–Cell and Nanoparticle–Cell Interactions: Applications in Oncology (Aleksandra Kaczorowska)	**9:00 – 9:45** Applications of Nanomaterials in Detection, Diagnostic, Therapeutic and Theranostic Techniques (Muhammet Emin Cam)	**9:00 – 10:45** How the Body Fights Cancer: The Role of the Immune System in Modern Therapies (Fernando Mendes)	**9:00 – 9:45** Methods of Elemental Analysis (Martin Kopáni)
11:15 – 12:00 Dental Biomaterials: Functionalization Strategies and the Role of Fluoride Release in Caries (Paweł Piszko)	**11:00 – 11:45** Assessment of leukemic cell resistance (Marta Kopaczyńska)	**10:00 – 10:45** Processing Methods and Applications of Nanomaterials (Ece Güler)	**11:00 – 12:45** How the Tumor Microenvironment Shapes Cancer Progression (Diana Martins)	**10:00 – 10:45** Particles of iron in cells and tissues (Martin Kopáni)
12:15 – 13:00 Protein drug carriers (Marlena Gąsior-Głogowska)	**12:00 – 13:45** Mysterious sol-gels - how abandoned ideas can become a driving force for industry (Agnieszka Ulatowska-Jarża)	**12:00 – 12:45** Introduction to Nanomedicine (Manuel Pedro Graça)		**11:00 – 11:45** The application of dendrimers in biomedical field (Sopio Melikishvili:)
		13:00 – 13:45 Piezoelectric Biomaterials in Medicine: A Review (Svitlana Kopyl)		**12:00 – 12:45** Understanding UV Spectroscopy: A Window into Molecular Structures (Radana Gurecká)
		14:00 – 15:45 Ethical Aspects in Nanomedicine (Svitlana Kopyl)		

All times are CEST. Attendance is required. All lectures will be recorded.

In-Person Program

Monday 13.07	Tuesday 14.07	Wednesday 15.07	Thursday 16.07	Friday 17.07
9:45 – 9:55 Welcome Session by Assoc. Prof. Muhammet Emin Çam	**9.00 - 10:45** How Personalized Medicine is Changing Cancer Treatment (Prof. Diana Martins)	**9.00 - 9:45** WorkShops[b]	**10.00 - 10:45** **Examination**	**9:00 – 13:00** SUNUM visit[f]
10.00 - 10:45 The Secret Language of Cells: Exploring Extracellular Vesicles (Dr. Kristína Lichá)	**11.00 - 12:45** Immunotherapy Basics: How Our Immune System Can Help Fight Cancer (Prof. Fernando Mendes)	**10.00 - 10:45** WorkShops[b]	**11.00 - 12:45** Introduction to Assessment Projects[d]	**14:00 – End** Social Program[a]
11.00 - 11:45 UV-VIS Spectroscopy – A Tool for Assessment of Concentration and Much More (Dr. Radana Gurecká)	**14.00 - 15:45** Magnetic Nanoparticles in Biomedicine (Prof. Pablo Hernandez Gomez)	**11.00 - 16:45** Case Study[c]	**14.00 - 15:45** Introduction to Assessment Projects[e]	
12.00 - 12:45 Targeting Tumour Metabolism with Smart Nanomedicines (Dr. Daniel Truchan)	**16.00 - 16:45** Bioactive Glasses: From Structure to Biomedical Applications (Prof. Manuel Pedro Graça)			
14:00 – End Social Program[a]				

a) Social programs will be announded; **b) Workshops:** Students will be divided into two groups that will attend both workshops (Cosmetics Production Workshop - Asst.Prof. Oğuzhan Aydemir & 3D Hydrogel Fabrication for Biomedical Applications - Asst. Prof. Ece Guler); **c) Case Study:** IR non-distructive measurements for real-time tracking in medicine and pharmacy (Prof. Joanna Bauer; in computer lab Z202); **d)** Project Numbers: 1, 2, 3, 5, 7, 9, 10; **e)** Project Numbers: 4, 6, 8, 11; **f)** Visit to Sabanci University Nanotechnology Research and Application Center (SUNUM)

Lunch will be served between between 13:00 – 14.00

Assessment Projects

Project Number	Project Title	Lecturer
1	Drug Delivery Systems in Cosmetics	Assoc. Prof. Muhammet Emin Cam (IKU)
2	Design of a nanomaterial-based hydrogel system for biomedical applications	Asst. Prof. Ece Guler (IKU)
3	Microfludic chips - scalable tools to design and fabricate drug carriers	Prof. Dominik Drabik (WUST)
4	Integrated AI-Supported Drug Candidate Design: From De Novo Molecular Generation to Toxicity Assessment	Prof. Matuesz Rzycki (WUST)
5	Perspectives in Treatment of Inflammatory Joint Diseases with Extracellular Vesicles	Dr. Kristína Lichá (CUB)
6	Applications of Spectroscopic Methods in Drug Delivery Research	Dr. Radana Gurecká (CUB)
7	Smart sensors for human breathing monitoring.	Prof. Manuel Pedro Graça (UA)
8	When Disorder Heals: The Power of Amorphous Materials in Nanomedicine”	Prof. Manuel Pedro Graça (UA)
9	Drug delivery by magnetoelectric nanoparticles	Prof. Pablo Hernandez Gomez (UV)
10	Nanomedicine-Based Modulation of the Immune Microenvironment in Triple-Negative Breast Cancer to Enhance Immunotherapy Efficacy	Prof. Fernando Mendes, Prof. Diana Martins (CU)
11	Targeted Nanoparticle Platforms for Immune Activation and Precision Treatment of Triple-Negative Breast Cancer	Prof. Fernando Mendes, Prof. Diana Martins (CU)

Participants

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Biosketch of Lecturers and Abstracts (Wrocław University of Science and Technology)

Name	Joanna Bauer, PhD Eng. Assist. Prof.
Affiliation	Department of Biomedical Engineering Faculty of Fundamental Problems of Technology Wrocław University of Science and Technology Poland
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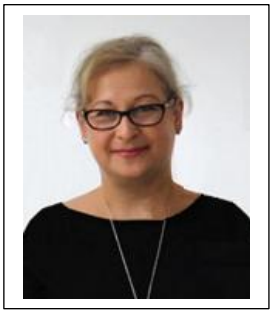

Biosketch

Joanna Bauer is an Assistant Professor in the Department of Biomedical Engineering at Wrocław Tech, Poland. She holds a PhD in Applied Physics, an MSc. Eng. in Management and Marketing, and a MSc. Eng. in Biomedical Engineering from the same university. She is an experienced academic researcher specialised in multidisciplinary biomedical engineering projects related to predictive, preventive and personalized medicine, nano-biomaterials functionalization and characterization, infrared imaging, as well as artificial intelligence′ applications for image analysis and pattern recognition.

Dr Bauer has extensive experience in carrying out national and international scientific projects within programmes such DAAD, ESF, FP6, FP7, and H2020 etc. She has also served as a Research Fellow and Visiting Scientist at numerous scientific institutions worldwide, including Charité – Universitätsmedizin, Germany; Oxford University, United Kingdom; University of Limerick, Ireland; Aveiro University, Portugal; Gunma University, Japan and several other reseerch centers and universities.

Lecture details

Title	IR non-destructive measurements for real-time tracking in medicine and pharmacy
Type	Lecture (in person)
Aim	The aim of the lecture is to introduce the fundamental principles and current applications of infrared non-destructive thermography in medicine and pharmacy. The lecture provides an overview of the physical basis of thermal imaging, thermographic measurement techniques, data interpretation methods, and the role of IR thermography in medical diagnostics, treatment monitoring, pharmaceutical quality control, and widebiomedical research
Learing Outcomes	Students will: • know and understand, at an advanced level, the physical principles, theories, phenomena and methodologies underlying infrared (IR) non-destructive thermography and its applications in medicine and pharmacy • have theoretically grounded knowledge of state-of-the-art thermographic imaging systems, data acquisition techniques, image processing methods and analytical tools used for real-time monitoring of biological tissues, pharmaceutical products and biomedical processes • understand the capabilities, limitations and practical aspects of non-invasive thermal diagnostics, including factors affecting measurement accuracy, reliability and interpretation of thermographic data in clinical and pharmaceutical environments

Workshop details

Title	IR non-destructive measurements for real-time tracking in medicine and pharmacy
Type	Workshop / Case Study
Aim	The aim of the workshop is to provide participants with theoretical knowledge and practical skills in the application of infrared thermography for real-time monitoring in medicine and pharmacy, including drug delivery systems. The workshop focuses on the principles of thermal imaging, operation and calibration of thermographic cameras, preparation of patients and samples for measurement, acquisition and analysis of

	thermal data, and interpretation of results for biomedical and pharmaceutical applications. Participants will gain hands-on experience in using IR thermography as a non-invasive tool for diagnostics, process monitoring, and quality assessment.
Learing Outcomes	**Student will able to:** • **operate and calibrate an infrared (IR) thermographic cameras to ensure accurate and reliable measurements** • **prepare patients, biological samples and pharmaceutical products for thermographic examination in accordance with standardized measurement protocols** • **identify and control environmental and procedural factors that may influence the quality and reproducibility of thermographic measurements** • **acquire, process and interpret thermal images using appropriate image analysis and data processing techniques** using dedicated software • **prepare technical reports and present the results of thermographic investigations in a clear and professional manner**

Name	Dominik Drabik
Affiliation	Department of Biomedical Engineering, Wrocław University of Science and Technology
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Biosketch
Dominik Drabik, PhD DSc, Eng. is an associate professor at the Department of Biomedical Engineering at Wrocław University of Science and Technology (WrocławTech). His scientific research operates at the intersection of simulation and experimental approaches for the characteristics of lipid membrane interaction and liposomal drug carriers. He successfully translates his research expertise into academic teaching, cutting through complex theories while leading university courses modelling of biological systems, biophysics, and the use of computer graphics for scienctific applications.

Lecture details

Title	Microfludic chips - scalable tools to design and fabricate drug carriers
Type	Lecture (in-person)
Aim	The primary objective of this lecture is to introduce students to the principles, design, and application of microfluidic chips as scalable tools for fabricating advanced drug carriers. The lecture will focus extensively on the encapsulation of therapeutic agents within liposomes and lipid nanoparticles (LNPs). Furthermore, the lecture aims to compare current microfluidic methodologies, explicitly detailing the operational differences and mixing mechanics between micromixers and Dean flow dynamics. Additionally, the critical roles of laminar and turbulent flow regimes in governing carrier size and homogeneity will be analyzed. Finally, the lecture will provide a foundational overview of Computational Fluid Dynamics (CFD) and demonstrate how simulation modeling is applied to optimize microfluidic chip design and performance.
Learing Outcomes	By the end of this lecture, participants will be able to: 1) Explain the principles of drug carrier fabrication using microfluidic approaches. 2) Differentiate between various microfluidic fabrication methods, including micromixers and Dean flow dynamics.

	3) Analyze the role of lamellar flow versus turbulent/recirculating flow regimes and their impact on vesicle formation. 4) Evaluate the advantages and disadvantages of using Computational Fluid Dynamics (CFD) approaches in microfluidic chip design.

Title	Microfludic chips - scalable tools to design and fabricate drug carriers
Type	Assessment Project
Aim	The objective of this assessment project is to design, simulate, and analyze a custom microfluidic chip using Computational Fluid Dynamics (CFD). Participants will gain practical experience with an end-to-end digital engineering workflow, beginning with 3D geometry design in Blender and progressing through mesh generation using snappyHexMesh. Students will then configure and execute fluid flow simulations using OpenFOAM within a Linux environment. Finally, using ParaView and other tools, participants will visualize the simulation outputs, evaluate velocity profiles and mixing behaviors, and interpret the data to optimize chip performance.
Learing Outcomes	By participating in this assessment project, participants will be able to: 1) Develop custom 3D geometries of microfluidic chips using Blender, ensuring appropriate scaling and compatibility for fluid simulations. 2) Configure and execute multiphysics fluid simulations within OpenFOAM, utilizing snappyHexMesh for grid generation inside a Linux environment. 3) Analyze and interpret complex CFD datasets using ParaView to evaluate velocity fields, pressure drops, and mixing efficiency.

Name	Marlena Gąsior-Głogowska, PhD Eng.	
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Contact Details	marlena.gasior-glogowska@pwr.edu.pl ORCID: 0000-0002-7835-7523 Tel.: +48 71 320 46 17 Room: D-1/119	

Biosketch
Marlena Gąsior-Głogowska is an assistant professor at the Department of Biomedical Engineering, Faculty of Fundamental Problems of Technology, Wrocław University of Science and Technology. Her scientific work focuses on biomedical applications of vibrational spectroscopy and spectroscopic imaging, particularly FTIR/ATR-FTIR and Raman-based methods, for the characterization of tissues, blood components, proteins, amyloid and biofilm-related structures, oxidative stress, biomaterials, and drug-cell or biomolecule interactions. She has co-authored studies on bacterial amyloid proteins, peptide and protein aggregation, microbiology, vascular and tissue diagnostics, and spectroscopic methods in biomedical engineering. Her research and teaching activities combine biomedical engineering, biophysics, biomolecular spectroscopy and translational characterization of protein- and biomaterial-based systems.

Lecture details

Title	Protein drug carriers
Type	Lecture (online)
Aim	To introduce protein-based drug carriers as biomolecular platforms for drug delivery, with emphasis on the relationship between protein structure, physicochemical stability, loading capacity, biological interactions, targeting potential and translational biomedical applications.
Learning Outcomes	• explain why proteins, peptides and protein assemblies can serve as drug-delivery carriers. • describe key structural and physicochemical factors governing carrier stability, loading, targeting and release. • discuss representative protein- and peptide-based carrier systems and their biomedical applications.

	• identify experimental approaches, including vibrational spectroscopy and imaging methods, used to characterize protein carriers and protein-drug interactions. • critically evaluate advantages, limitations, safety issues and translational challenges of protein drug carriers.

Name	Dr Paweł J. Piszko
Affiliation	Department of Biomedical Engineering, Wrocław University of Science and Technology
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Biosketch
Dr. Paweł J. Piszko is an Assistant Professor at Wrocław University of Science and Technology, where he works in the field of biomaterials, with research spanning dentistry and tissue engineering. Dr Paweł's research focuses on the development of novel dental biomaterials with enhanced cariostatic and remineralization properties for application in conservative dentistry. His subsequent work explores the synthesis of functional polymeric matrices for tissue engineering applications. Dr. Piszko has authored 26 international scientific publications, with over 680 citations to date. He is also a recipient of the prestigious START scholarship from the Foundation for Polish Science (FNP), awarded to outstanding early-career researchers.

Lecture details

Title	Dental Biomaterials: Functionalization Strategies and the Role of Fluoride Release in Caries
Type	Lecture (online)
Aim	The lecture aims to introduce caries as a highly prevalent oral disease and present functionalization strategies for caries prevention in dental biomaterials, with particular emphasis on how fluoride-releasing systems contribute to caries prevention
Learning Outcomes	1. Knowledge of the role of dental biomaterials in caries prevention and minimally invasive dentistry 2. Understanding of major functionalization strategies used to improve the performance of dental materials 3. Insight into the mechanisms of fluoride release and its contribution to remineralization and antibacterial activity

Details of Lecturer

Name	Aleksandra Kaczorowska
Affiliation	Department of Biomedical Engineering, Faculty of Fundamental Problems of Technology, Wrocław University of Science and Technology
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Biosketch
Aleksandra Kaczorowska, PhD, Eng. is an assistant professor at the Department of Biomedical Engineering at Wrocław Tech. Her scientific research operates at the intersection of medical biology and biomedical engineering, with a primary focus on uncovering the mechanisms of drug resistance in hematological malignancies. She successfully translates her research expertise into academic teaching, cutting through complex theories while leading university courses in *in vitro* preclinical studies and medical imaging techniques. Beyond the lab and the lecture hall, she is passionate about birdwatching and strength training.

Lecture details

Title	Analytical Approaches to Characterize Drug–Cell and Nanoparticle–Cell Interactions: Applications in Oncology
Type	Lecture (online)
Aim	The aim of this lecture is to introduce students to modern analytical and biophysical approaches used to investigate the interactions between therapeutic molecules or nanocarriers and target cells, emphasizing the transition from visual localization to quantitative evaluation in biomedical research.
Learing Outcomes	By the end of this lecture, participants will be able to: 1. Explain how different analytical methods complement each other by providing either spatial localization

	(imaging) or statistical data (quantification) regarding drug-cell interactions. 2. Interpret analytical data related to how cells internalize, accumulate, or clear therapeutic agents. 3. Describe the importance of measuring binding affinity and interaction kinetics when designing and optimizing targeted drug delivery systems.

Name	Prof. Marta Kopaczyńska
Affiliation	Department of Biomedical Engineering, Faculty of Fundamental Problems of Technology, Wrocław University of Science and Technology. Multiscale Bioimaging Research Group.
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Biosketch

Professor Marta Kopaczyńska has professional experiences include biomedical engineering, biomedical application of nanomaterials, biomolecular imaging, photodynamic medicine, organic and coordination chemistry. She is a specialist in high-resolution microscopic techniques (Atomic Force Microscopy (AFM) and Transmission Electron Microscopy (TEM)) and biomedical measurements in nanoscale by using Optical Tweezers and spectroscopy. Her research projects focus on the implementation of cardiovascular stents for interventional cardiology and oncology research projects investigating the mechanisms of chemosensitivity and chemoresistance of cancer cells. She has and experience in analyzing and commercialization of innovative technology, transfer and cooperation with local and foreign industry.

Lecture details

Title	Assessment of leukemic cell resistance
Type	Lecture online
Aim	Knowledge of medical imaging techniques at the cellular and nanoscale level. Application of molecular techniques in the diagnosis of oncological diseases.
Learing Outcomes	• Obtain basic knowledge of medical imaging techniques at the microscopic level • Acquire knowledge of the construction and operation of diagnostic devices used for diagnosis in the clinic • Obtain the possibilities of using chemoresistance test in oncology

Name	Sebastian Kraszewski, DSc PhD Med.Res.Eng.	
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Biosketch
Sebastian Kraszewski is an associate professor at Wrocław University of Science and Technology, Department of Biomedical Engineering, where he leads the MEDΦ Laboratory (Molecular Events & Design of Pharmaceuticals). He graduated in biomedical engineering from WUST, obtained his PhD in physics at Université de Franche-Comté in Besançon, France, and habilitation in biocybernetics and biomedical engineering at Silesian University of Technology. His research connects molecular dynamics and computational biophysics of biological membranes with AI-supported biomedical data analysis, drug-discovery workflows, digital health, and clinical decision-support systems. He works on membrane proteins, antimicrobial and metabolic therapies, lipid-based delivery systems and translational AI in medicine. He is Scientific Director of Scientific Center for Neuroinnovation (ncni.pl) and contributes to interdisciplinary initiatives in metabolic health, neurotechnology, responsible AI and future competences, including Polish Society for the Treatment of Insulin Resistance (ptli.pl), Head of the Health Section in the AI Expert Group at the Polish Ministry of Digital Affairs and Expert in the field of biomedical engineering at the Connecting the Future Foundation.

Lecture details

Title	Future perspectives on the integration of lipid nanoparticles with AI-driven drug delivery systems
Type	Lecture (online)
Aim	To provide an integrated overview of lipid nanoparticles as nucleic-acid drug delivery platforms and to explain how AI/ML methods can accelerate formulation optimization, predict physicochemical and biological performance, support targeting and biodistribution strategies, and enable emerging personalized and closed-loop therapeutic concepts.
Learning Outcomes	• Explain the structural design principles of lipid nanoparticles, including the roles of ionizable lipids, helper phospholipids, cholesterol and PEGylated lipids.

	• Describe key biological barriers in LNP-mediated delivery, including biodistribution, protein corona formation and endosomal escape. • Identify major AI/ML approaches used in LNP development, including supervised learning, random forests, transformers, generative models and active learning. • Discuss how AI-enabled concepts such as digital twins, biosensors, closed-loop dosing and point-of-care manufacturing may shape future intelligent nanomedicine. • Critically evaluate translational, safety, ethical and regulatory limitations of AI-driven LNP drug delivery systems.

Name	Agnieszka Ulatowska-Jarża
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Biosketch

I graduated with a degree in Biomedical Engineering from the Wrocław University of Science and Technology in 1997. In 2001, I obtained a PhD with honours in Natural Sciences (Physical Sciences) from the Institute of Physics at the same University. I then spent a year working as a postdoctoral researcher on my own project at the Institute of Biomedical Technology and Laser Medicine at Charité – University Medicine Berlin in Germany. I then returned to my home university as an Alexander von Humboldt Foundation Fellow for scientists from Central and Eastern Europe. Since 2013, I have been a habilitated doctor specialising in Biomedical Engineering at the Institute of Biocybernetics and Biomedical Engineering of the Polish Academy of Sciences in Warsaw, Poland.

I am currently an associate professor in the department of biomedical engineering at the faculty of fundamental problems of technology at Wrocław University of Science and Technology in Poland.

My research interests include applying optical phenomena to medical and microbiological diagnostics, and developing therapeutic procedures based on the interaction between biological matter and light. I am a co-author of several patents concerning sensing and therapeutic materials. I primarily research the application of microscopy (optical, infrared and Kelvin probe), multispectral and holotomographic techniques to monitor bacterial biofilm formation and development on various surfaces and in different media. I also examine photodynamic therapy mechanisms for the inactivation of microorganisms, particularly in combination with efflux pump inhibitors. https://orcid.org/0000-0003-2690-7885

Lecture details

Title	Mysterious sol-gels - how abandoned ideas can become a driving force for industry
Type	Lecture (online)
Aim	Learning about the theory of sol-gel material formation, research procedures and models, and mechanisms of particle immobilisation, as well as facts about the application.
Learing Outcomes	Gaining knowledge about colloidal materials, including inorganic and organically modified ones, and their various applications.

Name	Mateusz Rzycki
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Biosketch
Dr. Mateusz Rzycki is a researcher in biomedical engineering, computational biophysics, and bioinformatics at Wroclaw University of Science and Technology. His scientific interests focus on computational biology and chemistry, molecular modelling of lipid membranes, interactions of antimicrobial agents with bacterial membranes, and AI-supported approaches to drug candidate design. His expertise combines computational chemistry, molecular docking, molecular dynamics simulations, and in silico evaluation of bioactive compounds.

Lecture details

Title	Integrated AI-Supported Drug Candidate Design: From De Novo Molecular Generation to Toxicity Assessment
Type	Lecture (in-person)
Aim	The aim of the lecture is to introduce students to the principles of AI-supported early-stage drug candidate design, with a focus on de novo molecular generation, basic molecular characterisation, molecular docking, and in silico toxicity assessment. The lecture will present how generative AI methods can be integrated with computational chemistry tools into a coherent workflow for the identification and preliminary evaluation of potential drug candidates.
Learing Outcomes	After completing the lecture, students will understand the main concepts, opportunities, and limitations of AI-supported drug discovery workflows. They will be able to describe the role of molecular generation, structure–activity analysis, docking, and toxicity prediction in early-stage medicinal chemistry and critically interpret computational results in the context of drug candidate selection.

Title	Integrated AI-Supported Drug Candidate Design: From De Novo Molecular Generation to Toxicity Assessment
Type	Assessment Project
Aim	The aim of the assessment project is to enable students to apply an integrated AI-supported workflow for the design and

	preliminary evaluation of drug-like molecules. Students will use selected computational tools to generate candidate structures, analyse their basic molecular properties, assess potential binding interactions, and evaluate predicted toxicity-related risks.
Learing Outcomes	After completing the assessment project, students will be able to perform a basic AI-supported drug candidate design workflow using selected generative and computational chemistry tools. They will develop practical skills in analysing, comparing, and critically selecting computationally generated molecules based on molecular properties, docking results, and in silico toxicity predictions.

Biosketch of Lecturers and Abstracts (Comenius University Bratislava)

Name	Radana Gurecká
Affiliation	Institute of Medical Physics and Biophysics, Faculty of Medicine, Comenius University in Bratislava, Slovakia
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Biosketch
Radana Gurecká received her MSc. Degree from Biomedical Physics and her PhD. degree from Normal and Pathological Physiology at Comenius University in Bratislava, Slovakia. Her main scientific interests are metabolic syndrome and cardiometabolic health, specifically in population of university students. She studies standard, as well as nonstandard markers of cardiometabolic risk, using wide range of methonds, including colorimetry and ELISA. She is a co-author of 30 scientific papers, cited more than 450 times (HI=9). She works as a teacher at Institute of Medical Physics and Biophysics, Faculty of Medicine, Comenius University in Bratislava, Slovakia.

Lecture details

Title	Understanding UV Spectroscopy: A Window into Molecular Structures
Type	Lecture (online)
Aim	The lecture aims to cover principles of atomic and molecular orbitals, energy states and excitation. It also explains the interaction of electromagnetic radiation with matter and use of spectroscopy for molecular structure analysis.
Learing Outcomes	Students will understand the concept of molecular orbitals and electronic transitions. They will also be able to interpret simple spectra and relate absorption features to molecular structure and conjugation.

Title	UV-VIS Spectroscopy – A Tool for Assessment of Concentration and Much More
Type	Lecture (in-person)
Aim	The aim of the lecture is to explain Lambert-Beer law, describe principles of spectrophotometer and how to use spetroscopic data to assess solution concentration. Different UV-VIS spectrocsopic methods will be described, together with their applications, but also limitations.

Learing Outcomes	Students will learn about standard UV-VIS spectroscopy instrumentation. They will be able to intepret experimental data, construct calibration curve and determine solution concentration using the Lambert-Beer law. They will gain knowledge about applications of UV-VIS spectroscopy in direct and indirect colomietric assays and ELISA method.

Title	Applications of Spectroscopic Methods in Drug Delivery Research
Type	Assessment Project
Aim	The aim of the project is to summerize up-to-date information about the use of spectroscopic methods in drug delivery research. Students should find relevant sources, take advantage of multidisciplinarity of their team, cooperate in creating and presenting their project.
Learing Outcomes	By the end of this project, students will explore and explain the role of spectroscopic methods in drug delivery research and analyze how these techniques are applied to characterize drug systems (e.g., structure, stability, and release). They will also present and evaluate relevant case studies or data to demonstrate the practical impact of spectroscopy in pharmaceutical development.

Details of Lecturer

Name	Martin Kopáni
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Contact Details	Martin.kopani@fmed.uniba.sk

Biosketch
Associate Professor Martin Kopáni has been involved in research and teaching at the Faculty of Medicine, Comenius University for more than two decades. His scientific interests focus on the application of physical methods in biomedical research, particularly scanning electron microscopy (SEM) combined with energy-dispersive X-ray microanalysis (EDX) and transmission electron microscopy (TEM). His work has contributed to the identification and characterization of chemical elements in human tissues and cells, including the detection of copper accumulation in Wilson's disease and iron deposits in hemochromatosis. In addition to his research activities, he actively supervises student research projects and participates in the education of medical students. He teaches courses related to biomedical physics, physical methods in pathology, and fundamental fixation and staining methods in histopathology. Associate Professor Kopáni regularly presents his research at international scientific conferences and publishes in peer-reviewed biomedical journals. He is currently affiliated with the Institute of Medical Physics and Biophysics, Faculty of Medicine, Comenius University in Bratislava.

Lecture details

Title	Particles of iron in cells and tissues
Type	Lecture (online)
Aim	The aim of this lecture is to provide an overview of the structure, occurrence, characterization, and biological significance of iron-containing particles in cells and tissues, with emphasis on their role in biophysics, physiology, pathology, and biomedical research.
Learing Outcomes	After completing this lecture, students will be able to describe the major forms of iron-containing particles found in cells and tissues and explain their biological functions. They will understand the principles of iron storage and biomineralization, become familiar with key methods used to characterize iron particles, and be able to interpret basic structural and magnetic data. Students will also recognize the importance of iron-containing particles in both normal physiology and diseases associated with disturbed iron homeostasis.

Title	Methods of elemental analysis
Type	Lecture (online)
Aim	The aim of this lecture is to introduce the fundamental methods of elemental analysis, with a particular focus on Energy-Dispersive X-ray Spectroscopy (EDX) and Particle-Induced X-ray Emission (PIXE). The lecture explains the physical principles, instrumentation, and analytical capabilities of these techniques for qualitative and quantitative elemental characterization. Special attention is given to their applications in materials science, environmental studies, archaeology, and other fields requiring non-destructive elemental analysis.
Learing Outcomes	After completing this lecture, students will understand the fundamental principles of elemental analysis and the mechanisms responsible for the production of characteristic X-rays. They will be able to explain the operating principles of Energy-Dispersive X-ray Spectroscopy (EDX) and Particle-Induced X-ray Emission (PIXE), evaluate their advantages and limitations, and distinguish between their typical areas of application. Students will also be capable of interpreting elemental spectra, identifying the elemental composition of samples, and selecting the most suitable analytical method for a given research or industrial problem.

Details of Lecturer

Name	Mgr. Kristína Lichá, PhD.
Affiliation	Institute of Medical Physics and Biophysics, Medical Faculty, Comenius University in Bratislava
Contact Details	kristina.licha@fmed.uniba.sk

Biosketch

Education:

- MSc. in Biomedical physics at Faculty of mathematics, physics and informatics, Comenius University in Bratislava (2021)
- PhD. In Normal and pathological physiology at Institute of Molecular Biomedicine, Medical faculty, Comenius University in Bratislava (2025)

Professional Experience:

- Postdoctoral Researcher at Institute of Medical Physics and Biophysics, Medical Faculty, Comenius University in Bratislava (2025 –)

Dr. Lichá specializes in the field of extracellular vesicles. Her research primarily focuses on extracellular vesicles, particularly exosomes, and their association with DNA – exosomal DNA. Whether and how is DNA associated with extracellular vesicles in physiological conditions and also in pathological states as a potential pro-inflammatory agent.

She has presented her research at several international conferences, including the COMBIVET and BSEV Symposium (2022, Tartu, Estonia), the 1st MOVE Symposium (2023, Málaga, Spain), the 19th RECOOP Bridges in Life Sciences Conference (2024, Bratislava, Slovakia), the ISEV Annual Meeting (2025, Vienna, Austria), the CzeSEV Meeting (2025, Prague, Czech Republic), and the 21st RECOOP Bridges in Life Sciences Conference (2026, Zagreb, Croatia).

During her doctoral studies, she attended the BSEV/COMBIVET Summer School, *“Basic Work with Extracellular Vesicles”*, in Tartu, Estonia. She also completed a one-year research internship at the Hematology-Oncology Laboratory of the Universitätsklinikum Essen in Germany. As a result of this internship, she co-authored two publications in the *Journal of Extracellular Vesicles*.

Lecture details

Title	The Secret Language of Cells: Exploring Extracellular Vesicles
Type	Lecture (in-person)
Aim	This lecture aims to introduce extracellular vesicles and their subtypes, including exosomes, microvesicles, and apoptotic bodies, with a particular focus on exosomes. It will cover the biogenesis, composition, functions, and therapeutic or delivery potential of extracellular vesicles.
Learing Outcomes	**After the lecture, participants will be able to:** • Describe the differences among the various types of extracellular vesicles. • Summarize the fundamental characteristics and biological roles of extracellular vesicles. • Discuss the therapeutic potential and delivery functions of extracellular vesicles.

Title	Perspectives in Treatment of Inflammatory Joint Diseases with Extracellular Vesicles
Type	Assessment Project
Aim	This project aims to demonstrate the potential of extracellular vesicles in the treatment of inflammatory joint diseases, including juvenile idiopathic arthritis. It seeks to address the question: Can small particles possess great therapeutic potential?
Learing Outcomes	**After completing the project, participants will be alble to:** • Apply scientific thinking to research questions and problem-solving. • Formulate hypotheses and define project objectives, as well as critically evaluate whether these objectives have been achieved. • Design appropriate methodologies for testing and evaluating research hypotheses.

Name	Mgr. Sopio Melikishvili, PhD
Affiliation	Institute of Medical Physics and Biophysics, Medical Faculty, Comenius University
Contact Details	sopio.melikishvili@fmed.uniba.sk

Biosketch
Mgr. Sopio Melikishvili, PhD is an assistant professor at the Institute of Medical Physics and Biophysics, Faculty of Medicine, Comenius University in Bratislava. She holds a PhD in biophysics, with her doctoral research focused on the interaction of polymer nanoparticles and dendrimers with biological membranes. Her scientific work lies at the interface of nanotechnology, biophysics, and biomedical applications. She co-authored several peer-reviewed publications in the field of biosensors, nanomaterials, and biomedical diagnostics. Her work includes the development of sensitive detection systems for biomolecules using acoustic wave biosensors and nanoparticle-based assays, achieving detection at sub-nanomolar concentrations relevant for clinical and biochemical analysis. She has also contributed to research on nanoparticle–membrane interactions and the effects of polymer coatings on cellular uptake, supporting the development of nanocarriers for biomedical use. She is also actively involved in teaching and academic training in medical physics and biophysics.

Lecture details

Title	The Application of Dendrimers in the Biomedical Field
Type	Lecture (online)
Aim	The aim of this lecture is to introduce dendrimers as a class of nanostructured materials and to explore their applications in biomedicine, particularly in drug delivery, diagnostics, and cancer therapy.
Learning Outcomes	Understand the structure and properties of dendrimers Explain their suitability for biomedical applications Describe their role in targeted drug delivery systems Identify current applications in cancer therapy and imaging

Biosketch of Lecturers and Abstracts (University of Aveiro)

Name	Manuel Pedro Fernandes Graça
Affiliation	Aveiro University
Contact Details	mpfg@ua.pt

Biosketch
Manuel Pedro Fernandes Graça (MPFG) holds an Habilitation and serves as Associate Professor in the Department of Physics at the University of Aveiro (Portugal). He is also an invited professor at the Federal University of Ceará (Brazil) and co-founder and CEO of Glass2Med, Lda, a deep-tech startup working on advanced biomaterials for regenerative medicine. He graduated in Physics Engineering, followed by an M.Sc. in Science and Materials Engineering and a Ph.D. in Physics, obtained through a joint programme between the University of Aveiro and the Federal University of Ceará (Brasil). His work centres on solid-state physics, advanced functional materials, and micro- and nanomaterials processing. He leads the Physics of Advanced Materials (PAMD) group at i3N – the Institute of Nanostructures, Nanomodelling and Nanofabrication – overseeing a multidisciplinary team of more than 80 researchers. Prof. Graça is author or co-author of 2 books, 37 book chapters, over 350 peer-reviewed journal articles, and 3 patents, with more than 10,000 citations and an h-index of 50 (Google Scholar). His invited lecture record exceeds 50 talks, among them 11 international plenary lectures in the past five years; since 2021 he has appeared in Stanford University's list of the world's Top 2% Most Influential Scientists. As Principal Investigator he has led 10 funded research projects and established collaborations spanning Europe, North Africa, South America, and Asia. To date he has supervised 56 postdoctoral researchers, 14 doctoral students, and 39 Master's dissertations, alongside sustained partnerships with high-technology companies aimed at knowledge transfer and industrial application. His trajectory reflects a consistent ability to bridge rigorous academic research and real-world application, from internationally recognised contributions to solid-state physics through to the founding of a biomedical startup.

Lecture details

Title	Introduction to Nanomedicine
Type	Lecture (online)
Aim	This lecture introduces nanomedicine to students who may have limited prior exposure to the field, covering core nanotechnology principles as applied to healthcare, the design and behaviour of nanomaterials in biological

	environments, and a range of current and emerging clinical uses – from drug delivery and diagnostics to regenerative medicine and personalised therapies.
Learing Outcomes	• Trace the historical development of nanotechnology, from early conceptual frameworks and the emergence of nanoscience instrumentation to the birth of nanomedicine as a field. • Define nanomedicine and articulate its relevance to contemporary healthcare and pharmaceutical development. • Identify and compare the principal classes of nanomaterials used in biomedical and pharmaceutical contexts. • Explain how size-dependent properties at the nanoscale shape the way these materials interact with biological systems, distribute in the body, and exert therapeutic effects. • Survey established and emerging nanomedicine applications across drug delivery, diagnostics, medical imaging, tissue engineering, regenerative medicine, and personalised therapy. • Examine the benefits, known limitations, safety profile, ethical dimensions, and regulatory hurdles that currently shape the path to clinical translation of nanomedicine products. • Assess where the field is heading – identifying open questions, technological gaps, and realistic near-term prospects for nanotechnology in biomedical and pharmaceutical research.

Title	Bioactive Glasses: From Structure to Biomedical Applications
Type	Lecture (in-person)
Aim	This lecture covers bioactive glasses from the ground up – tracing their history from Larry Hench's original 45S5 formulation, explaining how composition and structure govern their properties, and working through the underlying mechanisms of bioactivity. Processing routes and current clinical uses in bone repair, dentistry, and soft tissue regeneration are also addressed.
Learing Outcomes	• Trace the history of bioactive glasses from Hench's early work on 45S5 through to the current generation of therapeutic glass formulations. • Relate composition, network structure, and classification to the physical, chemical, and biological behaviour of these materials. • Explain the surface reaction sequence underlying bioactivity,

	including hydroxycarbonate apatite nucleation and the molecular-level dialogue with host tissue. • Describe the main processing and fabrication routes for producing bioactive glass scaffolds, coatings, and devices. • Map out the clinical and pre-clinical applications of bioactive glasses in bone regeneration, dental repair, soft tissue healing, drug release, and tissue engineering. • Weigh the advantages and limitations of bioactive glasses against competing biomaterials platforms. • Reflect on current directions in multifunctional glass design and the longer-term potential of these materials in precision medicine.

Title	Smart sensors for human breathing monitoring.
Type	Assessment Project
Aim	Students work individually or in small groups to design a conceptual smart sensing system for human breathing monitoring. The project draws on nanotechnology, biomaterials, biomedical engineering, and sensor science, and asks participants to ground their solution in a specific real-world context – clinical, sports performance, or personal wellness.
Learing Outcomes	• Explain why continuous or periodic respiratory monitoring matters clinically and in broader contexts including sports science, occupational health, and personalised medicine. • Survey and compare sensing technologies relevant to breathing monitoring – wearable, flexible, and nanomaterial-based – with attention to their respective trade-offs. • Assess how advanced materials and nanotechnology affect sensor sensitivity, selectivity, user comfort, and real-time data quality. • Propose a coherent smart breathing-monitoring system, addressing sensing principles, signal acquisition and processing, user constraints, and plausible clinical use cases. • Honestly appraise the technical feasibility, limitations, and ethical implications of the proposed design. • Contribute productively within a mixed-discipline team to prepare and defend a project proposal. • Present scientific and technical arguments with clarity in both written and oral formats.

Title	When Disorder Heals: The Power of Amorphous Materials in Nanomedicine
Type	Assessment Project
Aim	Groups of 3–4 students choose a specific biomedical challenge and investigate how the structural disorder inherent in amorphous materials – bioactive glasses, amorphous nanoparticles, or disordered pharmaceutical forms – can be turned into a therapeutic or diagnostic advantage. The project culminates in a written proposal and oral defence of a novel nanomedicine concept.
Learing Outcomes	• Explain what makes a material amorphous and contrast this with crystalline order at the structural and property level. • Account for how the absence of long-range order modifies the physical, chemical, and biological behaviour of nanomaterials. • Identify the main families of amorphous materials with nanomedicine relevance – bioactive glasses, amorphous nanoparticles, and disordered pharmaceutical formulations – and situate each within its application context. • Balance the genuine advantages of amorphous systems – dissolution rate, ion release kinetics, surface reactivity – against their known stability and scalability limitations in drug delivery, regenerative medicine, imaging, and theranostics. • Read and critically engage with current literature on amorphous nanomaterials in healthcare, distinguishing genuine advances from incremental or speculative claims. • Formulate and defend a novel nanomedicine concept grounded in amorphous material properties, targeting a clearly defined biomedical problem. • Function effectively as part of a mixed-discipline team through the full project cycle – from initial concept to written report and oral defence. • Convey scientific findings and innovation strategy in clear, precise language, both in writing and during the oral presentation.

Details of Lecturer

Name	Svitlana Kopyl
Affiliation	University of Aveiro, Dep. Physics
Contact Details	svitlanakopyl@ua.pt

Biosketch
Dr. Svitlana Kopyl received her PhD in Physical Chemistry from the Institute of General and Inorganic Chemistry (Ukraine) in 2005. She was a JSPS Fellow at the Institute of Biomaterials and Bioengineering, Tokyo Medical and Dental University (Japan) from 2006 to 2009, and has conducted research at the Institute of Carbon (Spain) and the City College of New York (USA). Since 2015, she has been a researcher at the University of Aveiro (Portugal), where her work focuses on ferroelectric biomaterials and energy harvesting systems. Dr. Kopyl was recognized as an Outstanding Junior Researcher at CICECO, University of Aveiro, in 2021. She is actively involved in international collaboration and Erasmus+ Blended Intensive Programmes (BIP), having organized and co-organized several editions across Europe. She regularly presents her research as an invited and keynote speaker and is a member of the European Materials Research Society and the Portuguese Chemical Society.

Lecture details

Title	Ethical Aspects in Nanomedicine
Type	Lecture (online)
Aim	To provide an understanding of the ethical implications of nanomedicine, focusing on nanomaterial toxicity, patient safety, risk assessment, and the responsible development of nanotechnology-based medical applications.
Learing Outcomes	Upon completion of this lecture, students will have a critical understanding of the ethical challenges associated with nanomedicine, particularly those arising from the potential toxicity and safety of nanomaterials. They will be able to evaluate the uncertainties related to the biological interactions, long-term effects, and risk assessment of nanomaterials used in medical applications. Students will develop the ability to analyze ethical issues concerning patient safety, informed consent, and responsible innovation, as well as to assess the role of regulatory frameworks in managing risks associated with emerging nanomedical technologies. Furthermore, they will be able to apply ethical principles to the evaluation of real-world nanomedicine research and clinical practices, balancing scientific advancement with societal responsibility.

Title	Piezoelectric Biomaterials in Medicine: A Review
Type	Lecture (online)
Aim	The aim of this lecture is to provide students with a comprehensive overview of piezoelectric biomaterials and their emerging role in medicine. The lecture will examine the fundamental principles of piezoelectricity in biological and synthetic materials, their interactions with living tissues, and their applications in tissue engineering, regenerative medicine, biosensing, and implantable medical devices. Particular emphasis will be placed on the relationship between material properties, biological responses, and clinical translation challenges.
Learing Outcomes	Upon completion of this lecture, students will be able to explain the fundamental mechanisms of piezoelectricity in biological and biomimetic materials and evaluate their relevance to physiological processes and medical applications. They will be able to critically assess the advantages and limitations of piezoelectric biomaterials used in tissue engineering, regenerative medicine, biosensors, and implantable devices. Students will develop the ability to analyze how material composition, structure, and electromechanical properties influence biological responses and therapeutic outcomes. Furthermore, they will be able to evaluate current research trends and challenges associated with the development, biocompatibility, and clinical translation of piezoelectric biomaterials in modern medicine.

Biosketch of Lecturers and Abstracts (University of Valladolid)

Name	Pablo Hernández Gómez
Affiliation	Univ. Valladolid
Contact Details	pablohg@uva.es

Biosketch
Professor Pablo Hernández Gómez studied Physics at Science Faculty from 1987 to 1992, PhD in Physics in 1997 and Electronic Engineering in 1998. It has been recipient of Doctorate award in 1999, and silver medal of Valladolid University in 2019. He joined the Department of Electricity and Electronics in 1993, and since 2000 is associate professor at Valladolid University in Spain. His teaching activities include giving lectures in the electromagnetism area at undergraduate, master and doctorate level. His scientific work is devoted to the research of magnetic properties of materials, especially magnetic ferrites. Initially the research was focused on magnetic relaxation in bulk ferrites, and at present it is in the fabrication and magnetic characterization of nanoparticle hexaferrites. It has about 200 publications and international conference communications.

Lecture details

Title	Magnetic Nanoparticles for Biomedicine
Type	Lecture (in-person)
Aim	Nanoparticles are particles with dimensions between molecules and microscopic structures, therefore they can interact with human tissues at cellular level. Among them, magnetic nanoparticles have the particularity of reacting to magnetic fields, so this effect can be exploited to move them inside tissues using external magnetic fields, guiding them to areas of interest in order to release therapeutic agents in a localised manner, or to heat unwanted tissues using magnetic energy, or to serve as a contrast element in medical images. In this talk, once the essential physical concepts involved in the use of this type of nanomaterial have been reviewed, all of these applications will be described.
Learing Outcomes	Nanomaterials in diagnostics, medical imaging and drug delivery.

Title	Drug delivery by magnetoelectric nanoparticles
Type	Assessment Project
Aim	Magnetoelectric (ME) drug delivery is a targeted therapeutic approach using magnetoelectric nanoparticles that convert externally applied magnetic fields into localized electric signals within the body. These nanocarriers can enable highly localized, on-demand drug release and targeted cell destruction. In this project, the bibliographic study of foundations, materials, and state of the art of this technique will be analyzed.
Learing Outcomes	Group work, bibliography analysis, approach to a new topic

Biosketch of Lecturers and Abstracts (University of Coimbra)

Name	Diana Martins
Affiliation	1. Polytechnic University of Coimbra, 3045-093 Coimbra, Portugal 2. H&TRC-Health & Technology Research Center, Coimbra Health School, Polytechnic University of Coimbra, 3045-043 Coimbra, Portugal 3. Biophysics Institute of Faculty of Medicine, Coimbra Institute for Clinical and Biomedical Research (iCBR) Area of Environment Genetics and Oncobiology (CIMAGO), University of Coimbra, 3000-548 Coimbra, Portugal 4. Center for Innovative Biomedicine and Biotechnology, University of Coimbra, 3004-504 Coimbra, Portugal
Contact Details	diana.martins@estesc.ipc.pt

Biosketch
Diana Martins holds a PhD in Pathology and Molecular Genetics from the University of Porto, Portugal. She currently serves as an Associate Professor at the Coimbra Health School, Polytechnic University of Coimbra, where she is also Course Coordinator of the Bachelor's Degree in Biomedical Laboratory Sciences. Throughout her academic career, she has authored approximately 40 articles published in peer-reviewed, indexed scientific journals, and has participated as principal or co-investigator in funded research projects. Diana has published 3 book-chapters and 1 patent. She has supervised undergraduate theses, master and PhD theses, reflecting a strong and sustained commitment to mentoring the next generation of researchers in the biomedical sciences. Her main areas of research are cancer, namely tumour genetics, microenvironment and microbiome. In addition to her research and teaching activities, Diana Martins serves as Editor-in-Chief of the journal *Trends in Biomedical Laboratory Sciences* and regularly acts as a peer reviewer for scientific journals in her field.

Lecture details

Title	**How the Tumour Microenvironment Shapes Cancer Progression**
Type	Lecture (online)
Aim	This session aims to provide students with a comprehensive understanding of the tumour microenvironment (TME) as an

	active determinant of cancer progression, exploring the cellular and molecular interactions that drive immune evasion, angiogenesis, extracellular matrix remodelling, and therapeutic resistance, while highlighting emerging TME-targeted therapeutic strategies and precision oncology approaches.
Learing Outcomes	By the end of this session, students should be able to: 1. Describe the main cellular and molecular components of the tumour microenvironment (immune cells, CAF, endothelial cells, ECM, and soluble mediators). 2. Explain the dual/paradoxical role of immune cells within the TME, distinguishing anti-tumour effector responses from immunosuppressive mechanisms mediated by Treg and TAM (M2 phenotype). 3. Identify the key soluble mediators (TGF-β, VEGF, IL-10) involved in immunosuppression and angiogenesis within the TME. 4. Discuss the role of cancer-associated fibroblasts in ECM remodelling and its impact on drug penetration and immune cell infiltration. 5. Explain how hypoxia and HIF-1α signalling contribute to angiogenesis, metabolic reprogramming, and selection of aggressive, metastatic tumour clones. 6. Describe emerging therapeutic strategies targeting the TME, including anti-angiogenic agents, CAF-targeting approaches, TAM reprogramming, and combined immune checkpoint therapies. 7. Recognise the contribution of spatial transcriptomics and single-cell technologies to advancing precision oncology.

Title	**How Personalised Medicine is Changing Cancer Treatment**
Type	Lecture (in-person)
Aim	This session aims to provide students with an understanding of how personalised medicine (precision oncology) is transforming cancer treatment, exploring the molecular and genomic technologies that enable tailored therapeutic strategies, the role of biomarkers and liquid biopsy in patient stratification and monitoring, and the contribution of artificial intelligence and multi-omics approaches to advancing predictive, individualised cancer care.

Learing Outcomes	By the end of this session, students should be able to: 1. Explain the paradigm shift from the traditional "one-size-fits-all" approach to personalised, biomarker-driven cancer treatment. 2. Describe the role of next-generation sequencing (NGS) in profiling tumour mutational burden, somatic mutations, copy number variations, and gene fusions. 3. Identify key actionable molecular alterations (e.g., EGFR mutations, BRCA1/2 mutations, BCR-ABL translocations) and their corresponding targeted therapies. 4. Explain the principles and clinical applications of liquid biopsy, including ctDNA, circulating tumour cells, and exosomes, in tumour monitoring and detection of resistance mechanisms. 5. Discuss the role of biomarkers such as PD-L1 expression, microsatellite instability (MSI), and tumour mutational burden (TMB) in guiding immunotherapy selection. 6. Describe how pharmacogenomics contributes to predicting drug metabolism and toxicity, supporting individualised treatment decisions. 7. Recognise the role of artificial intelligence and multi-omics data integration in identifying novel therapeutic targets and predicting treatment response.

Title	**Nanomedicine-Based Modulation of the Immune Microenvironment in Triple-Negative Breast Cancer to Enhance Immunotherapy Efficacy**
Type	Assessment project
Aim	To investigate how engineered nanomedicine platforms can selectively modulate the immunosuppressive tumour microenvironment of triple-negative breast cancer (TNBC), converting it into an immune-permissive state that potentiates the efficacy of existing and novel immunotherapeutic strategies, with a view to improving clinical outcomes in patients with limited therapeutic options.
Learning Outcomes	Generate preclinical proof-of-concept evidence that nanomedicine-based TME reprogramming enhances

	immunotherapy response rates in TNBC models beyond what is achievable with checkpoint inhibition alone. Contribute a translatable nanomedicine platform design with defined physicochemical parameters, targeting ligands, and cargo specifications, suitable for scale-up and regulatory evaluation. Produce a peer-reviewed scientific output original research article, systematic review, or conference communication, disseminating findings within the nanomedicine and oncology communities.

Title	**Targeted Nanoparticle Platforms for Immune Activation and Precision Treatment of Triple-Negative Breast Cancer**
Type	Assessment project
Aim	To develop and validate targeted nanoparticle platforms capable of delivering immunostimulatory and cytotoxic payloads with tumour-cell precision to triple-negative breast cancer, thereby activating antitumour immune responses, overcoming immunosuppression, and enabling a precision treatment strategy that integrates nanomedicine with immunotherapy for improved therapeutic efficacy and reduced systemic toxicity.
Learning Outcomes	Deliver preclinical proof-of-concept evidence that precision-targeted nanoparticle platforms can synergistically activate antitumour immunity and enhance checkpoint inhibitor efficacy in TNBC beyond monotherapy benchmarks. Primary scientific contribution Establish a reproducible, scalable nanoparticle platform with defined manufacturing parameters, quality attributes, and a regulatory-relevant characterisation dataset, positioning the platform for IND-enabling studies. Translational platform contribution Provide a biomarker framework linking nanoparticle-immune interaction signatures to treatment response, contributing to the precision oncology rationale for patient stratification in future TNBC clinical trials. Precision medicine contribution Disseminate findings through at least one peer-reviewed publication in a nanomedicine or oncology journal and contribute to scientific discourse through conference presentation, advancing the field of nanoparticle-mediated cancer immunotherapy.

Name	Fernando Mendes
Affiliation	1 - Polytechnic University of Coimbra, 3045-093 Coimbra, Portugal; 2 - H&TRC-Health & Technology Research Center, Coimbra Health School, Polytechnic University of Coimbra, 3045-043 Coimbra, Portugal; 3 - Biophysics Institute of Faculty of Medicine, Coimbra Institute for Clinical and Biomedical Research (iCBR) Area of Environment Genetics and Oncobiology (CIMAGO), University of Coimbra, 3000-548 Coimbra, Portugal; 4 - Center for Innovative Biomedicine and Biotechnology, University of Coimbra, 3004-504 Coimbra, Portugal; 5 - European Association of Biomedical Scientists, B-1000 Brussels, Belgium
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Biosketch

Fernando Mendes (FM) is a Coordinating Professor at the Scientific-Pedagogical Unit of Biomedical Laboratory Sciences, Polytechnic University of Coimbra, and an integrated researcher at the Health & Technology Research Center (H&TRC). He is also a collaborator researcher at the Center for Innovative Biomedicine and Biotechnology (CIBB), University of Coimbra. He obtained his PhD in Medical Sciences in 2016 from the Faculty of Medicine, University of Coimbra. His research activity is developed within multidisciplinary teams, focusing on Oncology and Biophysics. FM has a strong scientific output, including forty-nine peer-reviewed full-text publications, four books, and six book chapters, as well as more than twenty abstracts published in scientific journals and over 120 abstracts in conference proceedings. He has delivered more than fifty invited communications and co-authored over two hundred posters presented at international scientific meetings. He has experience in supervision, having supervised more than sixty undergraduate students, six master's theses, and five innovation and entrepreneurship projects, and is currently supervising 2 PhD candidates. FM is the inventor/co-inventor of seven granted patents and has contributed to more than ten provisional patent applications submitted in Portugal and Brazil. Through international collaboration, particularly with Brazilian institutions, he has participated as an invited researcher in more than twenty funded research projects. In recent years, his research has focused on cancer treatment, particularly radiotherapy and immunotherapy. His work explores the role of the immune system and immune checkpoint inhibitors in cancer, including prostate, bladder, and penile cancers, aiming to contribute to improved therapeutic strategies and patient

outcomes. He has served as Guest Editor for several international journals and special issues, including the European Journal of Public Health, Cancers, Nutrients, and Biomedicines, Frontiers in Oncology, addressing topics such as innovative cancer therapies, thoracic neuroendocrine tumors, nutritional interventions in oncology, and the tumour microenvironment. FM is an active peer reviewer, having reviewed more than 160 manuscripts for international scientific journals. His work has been recognized with ten awards and distinctions.

Lecture details

Title	How the Body Fights Cancer: The Role of the Immune System in Modern Therapies
Type	Lecture (online)
Aim	To provide students with a comprehensive understanding of the mechanisms by which the immune system recognises and eliminates tumour cells, how tumours evade immune surveillance, and how modern immunotherapeutic strategies exploit this knowledge to restore and enhance antitumour responses.
Learning Outcomes	Apply knowledge of PD-L1 expression and tumour mutational burden (TMB) as biomarkers to justify patient stratification in precision oncology. Analyse the rationale for combining immunotherapy with chemotherapy or radiotherapy, considering synergistic mechanisms and clinical evidence. Critically evaluate the principal challenges of current immunotherapy, including tumour heterogeneity, adaptive resistance, and immune-related adverse events (irAE).

Title	Immunotherapy Basics: How Our Immune System Can Help Fight Cancer
Type	Lecture (in-person)
Aim	To enable students to understand the biological basis of cancer immunotherapy, characterise the principal immunotherapeutic strategies currently in clinical use, and critically appraise their clinical outcomes, limitations, and future directions in the context of precision oncology.
Learning Outcomes	Apply clinical evidence from tumour types such as melanoma, lung, bladder, and haematological cancers to justify the use of immunotherapy in biomarker-selected patient populations.

	Evaluate the role of predictive biomarkers in optimising patient selection and maximising therapeutic efficacy while minimising immune-related toxicity. Analyse the principal challenges of current immunotherapy — including resistance mechanisms, immune-related adverse events, and tumour heterogeneity — and discuss emerging combination strategies to address them.

Title	Nanomedicine-Based Modulation of the Immune Microenvironment in Triple-Negative Breast Cancer to Enhance Immunotherapy Efficacy
Type	Assessment project
Aim	To investigate how engineered nanomedicine platforms can selectively modulate the immunosuppressive tumour microenvironment of triple-negative breast cancer (TNBC), converting it into an immune-permissive state that potentiates the efficacy of existing and novel immunotherapeutic strategies, with a view to improving clinical outcomes in patients with limited therapeutic options.
Learning Outcomes	Generate preclinical proof-of-concept evidence that nanomedicine-based TME reprogramming enhances immunotherapy response rates in TNBC models beyond what is achievable with checkpoint inhibition alone. Contribute a translatable nanomedicine platform design with defined physicochemical parameters, targeting ligands, and cargo specifications, suitable for scale-up and regulatory evaluation. Produce a peer-reviewed scientific output original research article, systematic review, or conference communication, disseminating findings within the nanomedicine and oncology communities.

Title	Targeted Nanoparticle Platforms for Immune Activation and Precision Treatment of Triple-Negative Breast Cancer
Type	Assessment project
Aim	To develop and validate targeted nanoparticle platforms capable of delivering immunostimulatory and cytotoxic payloads with tumour-cell precision to triple-negative breast cancer, thereby activating antitumour immune responses, overcoming immunosuppression, and enabling a precision treatment strategy that integrates nanomedicine with

	immunotherapy for improved therapeutic efficacy and reduced systemic toxicity.
Learning Outcomes	Deliver preclinical proof-of-concept evidence that precision-targeted nanoparticle platforms can synergistically activate antitumour immunity and enhance checkpoint inhibitor efficacy in TNBC beyond monotherapy benchmarks. Primary scientific contribution Establish a reproducible, scalable nanoparticle platform with defined manufacturing parameters, quality attributes, and a regulatory-relevant characterisation dataset, positioning the platform for IND-enabling studies. Translational platform contribution Provide a biomarker framework linking nanoparticle-immune interaction signatures to treatment response, contributing to the precision oncology rationale for patient stratification in future TNBC clinical trials. Precision medicine contribution Disseminate findings through at least one peer-reviewed publication in a nanomedicine or oncology journal and contribute to scientific discourse through conference presentation, advancing the field of nanoparticle-mediated cancer immunotherapy.

Biosketch of Lecturers and Abstracts (Istanbul Kent University)

Name	Asiss. Prof. Oğuzhan Aydemir
Affiliation	Istanbul Kent University
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Biosketch
Assist. Prof. Dr. Oğuzhan Aydemir is a pharmacist, academician, and entrepreneur affiliated with Istanbul Kent University. His academic research predominantly focuses on neuropharmacology, specifically targeting neuroinflammation, Alzheimer's disease, microglial polarization, and the Nrf2 signaling pathway. Bridging the gap between academic research and the commercial industry, Dr. Aydemir is the founder of Nanoceutical Tech OÜ, headquartered in Estonia, focusing on global R&D and the commercialization of bioactive formulations. He is also a founding partner and the production facility manager of Formule de Beauté Cosmetics Inc., where he leads the development of advanced product lines, including anti-hair loss serums and shampoos featuring exosomes and postbiotics. His formulation expertise centers on advanced cosmetic and pharmaceutical research utilizing nanotechnology, particularly the development and characterization of nanocarrier systems such as liposomes, niosomes, and exosomes. Additionally, Dr. Aydemir highly specializes in regulatory compliance and toxicological safety assessments for cosmetic and supplement production, strictly applying evaluation metrics such as SED, NOAEL, and MoS.

Lecture details

Title	Novel Emulsion Systems in Pharmacology and Cosmetics
Type	Lecture (online)
Aim	• To introduce the fundamental concepts and structural differences of novel emulsions, including nanoemulsions, microemulsions, Pickering emulsions, and multiple emulsions (W/O/W, O/W/O). • To explain how novel emulsion systems enhance the stability, solubility, skin penetration, and bioavailability of active pharmaceutical and cosmetic ingredients. • To discuss advanced formulation techniques (e.g., high-pressure homogenization, phase inversion temperature) and evaluate characterization parameters like droplet size, polydispersity index (PDI), zeta potential, and rheological behavior.

	• To evaluate critical regulatory compliance and toxicological safety assessment metrics in novel emulsion formulation development, including Systemic Exposure Dose (SED), No Observed Adverse Effect Level (NOAEL), and Margin of Safety (MoS).
Learing Outcomes	• Students will be able to define various types of novel emulsions and explain their specific roles and advantages in modern pharmacological and cosmetic formulations. • Students will be able to describe how novel emulsion systems improve targeted delivery, controlled release, and bioavailability. • Students will be able to select appropriate formulation techniques and evaluate key characterization methods for complex emulsion systems. • Students will be able to prepare toxicological safety assessments and regulatory documentation for emulsion-based formulations

Title	Application of Novel Emulsions in Cosmetics
Type	Assessment Project
Aim	• To investigate the role of advanced delivery systems in improving the penetration, stability, and controlled release of active cosmetic ingredients. • To compare different novel cosmetic emulsion systems such as nanoemulsions, microemulsions, and Pickering emulsions against conventional formulations. • To evaluate how delivery systems can enhance the efficacy of cosmetic products targeting skin hydration, anti-aging, pigmentation, acne, hair care, and wound/skin barrier repair. • To design a science-based cosmetic product concept using an appropriate delivery system and justify its formulation, active ingredients, mechanism of action, safety, and market potential.
Learing Outcomes	• Students will be able to explain how advanced delivery systems improve the stability, penetration, controlled release, and bioavailability of cosmetic active ingredients. • Students will be able to compare different novel emulsion systems and their performance in cosmetic applications. • Students will be able to evaluate the suitability of specific delivery systems for cosmetic applications. • Students will be able to design a cosmetic product concept using an appropriate delivery system, seamlessly integrating novel emulsion technologies with rigorous safety and regulatory compliance (SED, NOAEL, MoS).

Name	Assoc. Prof. Muhammet Emin Cam
Affiliation	Istanbul Kent University
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Biosketch

Assoc. Prof. Muhammet Emin Cam graduated from the Faculty of Pharmacy at Marmara University in 2012 and completed his PhD in 2017 in the Department of Pharmacology at the same university. After completing his PhD, Dr. Cam began his academic career as a faculty member in the department where he obtained his doctoral degree. As of January 2024, he joined Istanbul Kent University, where he established the Faculty of Pharmacy, and he currently continues his academic and research activities there.

His research focuses on Alzheimer's disease, diabetes, medicinal plants, drug delivery systems and their production technologies, 3-D printing, and biomaterials. Dr. Cam conducted his postdoctoral research at University College London between 2018 and 2019. Since June 2018, he has been serving as a Visiting Professor in the Department of Mechanical Engineering at University College London, and since October 2022, he has been working as a Guest Lecturer in Biomedical Engineering at the University of Aveiro, where he also delivers postgraduate lectures. As of August 2025, he has been delivering postgraduate lectures as a Guest Lecturer in the Department of Biomedical Engineering at Wrocław University of Science and Technology in Poland. Between 2020 and 2022, he served as Vice Dean of the Faculty of Pharmacy at Marmara University.

Dr. Çam has authored more than 80 publications, most of which have been published in SCI-indexed journals. He also holds several national and international patents, has received numerous international publication awards, and has had his work featured on the cover of journals. He has actively participated in many TÜSEB, TÜBİTAK, and international projects. He currently serves as Vice Dean of the Faculty of Pharmacy at Istanbul Kent University, President and Consultant of the Scientific Board of Türk Kızılay Food & Beverage, and Scientific Consultant for Dermo Grup, Art de Huile, Formule de Beauté, and Cemer Playground Equipment.

Through MecNano Technologies, the company he founded, Dr. Çam develops drug delivery systems and devices designed to produce these systems, while also providing formulation development and consultancy services to numerous companies. To date, his publications have received more than 1,900 citations, and he has an h-index of 25 and an i10-index of 41. At the ISIF'25 International Invention Fair, he won a Silver Medal for his patent entitled "Functional Beverages with Enhanced Bioavailability and Their Production Methods." As of September 2025, Dr. Cam was included in the "World's Most Influential Scientists" list, prepared annually through the collaboration of Elsevier and Stanford University. He has supervised 6 PhD and 2 master's students to graduation and is currently supervising 3 PhD students.

Lecture details

Title	Applications of Nanomaterials in Detection, Diagnostic, Therapeutic and Theranostic Techniques
Type	Lecture (online)
Aim	• To introduce the fundamental role of nanomaterials in modern detection, diagnostic, therapeutic, and theranostic applications. • To explain how nanotechnology-based drug delivery systems can improve targeting, bioavailability, controlled release, and therapeutic efficacy. • To discuss different nanomaterial production technologies, including electrospinning, pressurized gyration, 3D printing, microfluidics, and nanoparticle fabrication. • To evaluate key characterization and biological testing methods such as SEM, TEM, drug release studies, antibacterial tests, cell culture, in vitro assays, and in vivo models. • To demonstrate translational examples of nanomaterials in diabetes, wound healing, Alzheimer's disease, cancer, bone tissue engineering, and personalized medicine applications.
Learing Outcomes	• Students will be able to define nanomaterials and explain their role in detection, diagnosis, therapy, and theranostic applications. • describe how nanotechnology-based drug delivery systems improve targeted delivery, controlled release, and bioavailability. • compare key nanomaterial fabrication techniques. • interpret basic characterization and biological evaluation methods. • evaluate real biomedical applications of nanomaterials in different diseases.

Title	Drug Delivery Systems in Cosmetics
Type	Assessment Project
Aim	• To investigate the role of drug delivery systems in improving the penetration, stability, and controlled release of active cosmetic ingredients.

	• To compare different cosmetic delivery systems such as liposomes, polymeric nanoparticles, hydrogels, nanofibers, and microneedles. • To evaluate how delivery systems can enhance the efficacy of cosmetic products targeting skin hydration, anti-aging, pigmentation, acne, hair care, and wound/skin barrier repair. • To design a science-based cosmetic product concept using an appropriate drug delivery system and justify its formulation, active ingredients, mechanism of action, safety, and market potential.
Learing Outcomes	• Students will be able to explain how drug delivery systems improve the stability, penetration, controlled release, and bioavailability of cosmetic active ingredients. • compare different cosmetic delivery systems, including liposomes, polymeric nanoparticles, hydrogels, nanofibers, and microneedles. • evaluate the suitability of specific delivery systems for cosmetic applications. • design a cosmetic product concept using an appropriate delivery system.

Name	Ece Guler
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Biosketch

Dr. Guler earned her Bachelor of Science in Pharmacy from the Faculty of Pharmacy at Marmara University in 2018 and completed her Ph.D. in Pharmacology at Marmara University in 2023. She has been working as an Assistant Professor in the Faculty of Pharmacy and director of ResearchKent at Istanbul Kent University since January 2024, continuing her research and teaching activities in pharmacology, nanotechnology, drug delivery systems, biomaterials, and regenerative medicine.

During her doctoral studies, Dr. Guler conducted extensive research using *in vivo* animal models of Alzheimer's disease, diabetes, epilepsy, inflammation, colitis, and wound healing. Her research primarily focused on developing nanotechnology-based drug delivery systems and advanced therapeutic approaches to treat complex diseases. Her doctoral thesis was recognized with the TÜBA Outstanding Doctoral Dissertation Award, one of the most prestigious scientific awards granted to young researchers in Türkiye.

Dr. Guler's research interests encompass nanomedicine, nanotechnology, biomaterials, drug delivery systems, tissue engineering, regenerative medicine, hydrogel technologies, and advanced pharmaceutical formulations. She has extensive experience in the design, characterization, and biomedical application of nanoparticles, nanofibers, hydrogels, and other nanostructured therapeutic platforms. More recently, her work has expanded toward three-dimensional biomaterial fabrication and biofabrication technologies for regenerative medicine applications.

Throughout her academic career, Dr. Guler has authored more than 20 SCI-indexed publications and a book chapter and has presented her research at numerous national and international scientific conferences through oral and poster presentations. Her work has received several academic distinctions, including awards for best oral presentation and recognition for scientific illustrations selected as cover artwork in leading international journals within the fields of pharmaceutical sciences and nanomedicine.

In recognition of her academic achievements, Dr. Guler was awarded prestigious national and international doctoral scholarships by both the Council of Higher Education of Türkiye (YÖK) and TÜBİTAK. She further enhanced her expertise through specialized training programs in entrepreneurship and nanotechnology in Spain and Portugal. In addition, she participated in international research collaborations and projects that provided advanced training opportunities in *in vitro* cell culture and biomedical research at COMSATS University (Pakistan) and University College London (UCL), United Kingdom.

Dr. Guler's publications have received more than 900 citations, and she currently holds an h-index of 15. Through her interdisciplinary research activities, she continues to contribute to the advancement of nanotechnology-based healthcare solutions by integrating pharmaceutical sciences, materials science, and biomedical engineering to address unmet clinical needs.

Lecture details

Title	Processing Methods and Applications of Nanomaterials
Type	Lecture (online)
Aim	To introduce the fundamental processing methods used in nanomaterial production and to provide an overview of their biomedical, pharmaceutical, and engineering applications. The lecture aims to familiarize participants with the relationship between fabrication techniques, material properties, and application performance.
Learing Outcomes	• Explain the fundamental concepts of nanotechnology and nanomaterials. • Compare top-down and bottom-up nanomaterial fabrication approaches. • Describe common nanomaterial processing methods, including nanoprecipitation, emulsification, electrospinning, and self-assembly. • Discuss the physicochemical properties influencing nanomaterial performance. • Evaluate biomedical and pharmaceutical applications of nanomaterials. • Identify current trends and challenges in nanomedicine and advanced material development.

Title	3D Hydrogel Fabrication for Biomedical Applications
Type	Workshop
Aim	To provide hands-on training on the preparation and fabrication of hydrogel-based biomaterials using three-dimensional manufacturing approaches for tissue engineering and regenerative medicine applications.
Learing Outcomes	• Explain the role of hydrogels in tissue engineering and regenerative medicine. • Select suitable natural and synthetic polymers for hydrogel fabrication. • Prepare hydrogel precursor solutions and optimize formulation parameters.

	• Produce hydrogel constructs using 3D fabrication techniques. • Assess key properties of hydrogels, including gelation behavior, mechanical stability, and swelling characteristics. • Discuss potential biomedical applications of 3D hydrogel systems.

Title	Design of a Nanomaterial-Based Hydrogel System for Biomedical Applications
Type	Assessment Project
Aim	To assess participants' ability to integrate knowledge gained from nanomaterial processing technologies and hydrogel fabrication by designing an innovative biomaterial-based solution for a selected biomedical application.
Learing Outcomes	• Apply fundamental principles of nanomaterial design and hydrogel fabrication to a real-world biomedical challenge. • Select appropriate materials and fabrication methods based on the intended application. • Develop a scientifically justified design for a nanomaterial-based hydrogel system. • Critically evaluate the advantages and limitations of the proposed formulation. • Present and communicate scientific concepts effectively through a written report and/or oral presentation. • Demonstrate problem-solving and interdisciplinary thinking skills in biomaterials research.

Biosketch of Lecturers and Abstracts (Slovak Academy of Sciences)

Name	Mgr. Daniel Truchan, PhD.
Affiliation	Institute of Physics, Slovak Academy of Sciences, Bratislava
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Biosketch
Daniel Truchan completed his MSc. in Biomedical Physics at Comenius University in Bratislava (*Summa cum laude*; Mgr.). He subsequently applied for the French Government Scholarship to pursue a joint PhD. (Cotutelle) between France and Slovakia. As a successful applicant, he joined the Laboratory for Vascular Translational Science at Université Sorbonne Paris Nord, working in close collaboration with Institut Curie. He had the opportunity to present his work in respected journals in nanoscience like ACS Omega (2023) or Discover Nano (2025) and in multiple conferences (HYMA 2022 in Genoa – Italy, NanoTech Poland 2023 in Poznań – Poland, SFNano 2023 in Montpellier – France, Nanocon 2024 in Brno – Czech republic, RamanFest 2024 in Paris – France). During his doctoral research, he developed and tested photothermally active MoO_x nanoparticles, investigating how their photothermal properties depend on reduction degree, pH, and cellular environment, alongside their cytotoxicity. This work led to several collaborative European scientific projects, including bilateral Partenariat Hubert Curien – Štefánik and multilateral Partenariat Hubert Curien – Danube Strategy programs. This effort led to inclusion of his team in a European ERA-NET Transcan-3 research project with partners from Slovakia, France, Austria, and Spain. In these projects, the Slovak team provides advanced methods like Confocal Raman Imaging, Biological Atomic Force Microscopy, Scaterring-type Near-field Optical Microscopy, nanoresolution Fourier transform Infrared spectroscopy. Scientific interests of Dr. Truchan include biosystem–nanoparticle interactions, intracellular localization of nanomaterials, cell-induced physicochemical transformations of nanomaterials, fundamental research on Polyoxometalates (POMs), and nanoparticle functionalization and stabilization strategies.

Lecture details

Title	Targeting Tumour Metabolism with Smart Nanomedicines
Type	Lecture (in-person)
Aim	To introduce the principles of tumour metabolism and the tumour-specific microenvironment it creates, and to demonstrate how these features can be strategically exploited in nanoparticle-mediated cancer treatment. The lecture will compare conventional therapeutic approaches with emerging

	nanomedicine strategies, with a particular focus on photothermal therapy and state-of-the-art instrumentation used for its implementation.
Learning Outcomes	After the lecture, participants will be able to: • Describe tumour specific metabolic features and the microenvironment they generate. • Outline how these metabolic traits can inform smart nanomedicine design. • Summarize key properties of MoOx nanomaterials relevant to photothermal applications. • Recognize current photothermal treatment technologies and their basic operational principles.