COLLOID BIOLOGY WEEK

10 November 2023

WINTER SCHOOL:

"Exploring microbial cell-surface and cell colloid interactions: advanced analytical methods"

SCHEDULE

Nª Lecture	TIME	TITLE	TEACHER
1	09:00 - 09:30	Advanced Strategies for Isolating Bacteria and Microbial Consortia Using Microfluidics, Aggregation and Encapsulation	Ales Lapanje
2	09:30 - 10:00	Bacterial biofilms: relevance and methods to evaluate the toxicity in these structures	Carlos Rumbo
3	10:00 - 10:30	Probing Biocolloids with Precision: Insights from Raman Spectroscopy and Atomic Force Microscopy	Andre Skirtach
	10:30 – 11:00	**COFFEE BREAK**	
4	11:00 - 11:30	Study of the Environmental Fate of Nanoparticles in Organisms using Radiotracing	Stefan Schymura
5	11:30 - 12:00	Dental bio-interface restoration using Ca-caseinate bio/nano colloids: a converged roughness parameter analysis via interferometric microscopy:	Stefan Schymura

SURFBIO project has received funding under the European Union's Horizon 2020 research & Innovation programme under grant agreement N° 952379

Advanced strategies for isolating bacteria and microbial consortia using microfluidics, aggregation and encapsulation

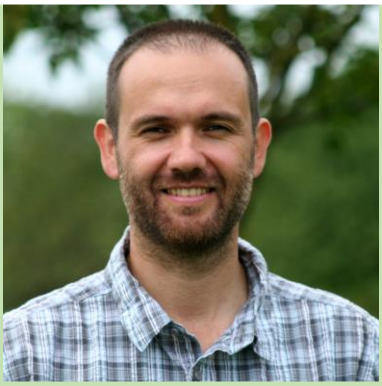
Aleš Lapanje, Tomaž Rijavec, Dmitrii Deev

Innovation Hub for Surface and Colloid Biology, Department of Environmental Sciences, Jozef Stefan Institute, Ljubljana, Slovenia

Microbial communities in natural environments exhibit intricate interactions among individual organisms. These interactions encompass various ecological relationships, such as metabolic exchanges (cross-feeding), interspecies dynamics (competition, predation, collaboration, symbiosis), and niche diversification, which enables the coexistence of different strains or species. The successful cultivation of individual cells or consortia with specific properties depends on several critical factors: (i) the isolation of strains from competitors and fast-growing counterparts, (ii) maintaining spatial organisation among strains, (iii) establishing beneficial interactions, and (iv) providing microenvironmental conditions that facilitate niche differentiation. Unfortunately, conventional microbiological techniques often fall short of meeting these criteria, resulting in a limited fraction of culturable bacteria.

In response to these challenges, we present a methodological framework that combines principles of colloid particle physics with microfluidics and microbiology. This approach enables the formation of unique microconsortia primed for diverse applications, particularly in bioremediation and mixed culture fermentations. The process involves several crucial steps: (i) characterising the physical properties of the sample to inform strategies for random aggregation, (ii) extracting cells from the samples, (iii) controlling the size of aggregates during random aggregation, (iv) cultivating microcontainers, and (v) selecting consortia or strains that exhibit specific advantageous traits.

By participating in this course, you will gain a deeper understanding of the isolation of microorganisms and acquire the foundational knowledge required to apply colloid biology techniques in microbiology. This educational opportunity offers a comprehensive exploration of microbial community dynamics, shedding light on their complex interactions and real-world applications.



Aleš Lapanje

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Aleš Lapanje is head of the Colloid Biology group at JSI and has successfully coordinated several national, international and industrial research projects. He has extensive knowledge of microbial community dynamics by using advanced molecular biology tools. During his research he has been developing methods that enable studying colloid-bacteria interactions, electrostatic interactions of bacterial cells and their entrapment in different matrices. Based on his approaches he contributed new insights in environmental toxicology, host-microbe interactions, plant-bacterial association, bioremediation as well as in medical field. He published more than 300 different scientific and professional contributions and 12 patents in the field of molecular and clinical microbiology.

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Bacterial biofilms: relevance and methods to evaluate the toxicity in these structures

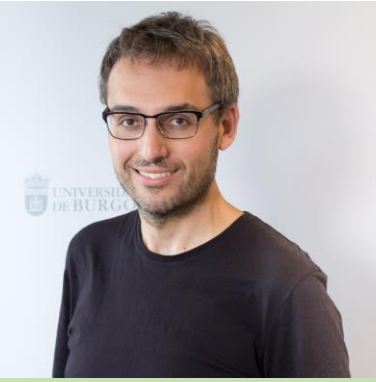
Carlos Rumbo Lorenzo

International Research Center in Critical Raw Materials for Advanced Industrial Technologies
Universidad de Burgos, Burgos, Spain

Biofilms are associations of microorganisms embedded in a complex self-produced matrix of different molecules (proteins, nucleic acids, polysaccharides), which provides a particular environment that protects microbes against environmental stress factors.

Biofilms can be found attached to both biotic and abiotic surfaces, and these structures present a critical role in many positive and negative aspects of human life. For example, biofilms are applied in several technologies, including bioremediation of groundwater and soils or wastewater treatment. On the other hand, in the biomedical field, biofilms are associated with several hospital-acquired infections, as well as being involved in the contamination of medical devices.

Considering the high impact of biofilms for humans and the environment, understanding the different processes associated to them is a priority for the scientific community. In the present lecture, several general aspects regarding biofilms and their relevance are presented, as well as different methodologies to study the toxicity in these structures.



Carlos Rumbo Lorenzo

Senior researcher at International Research Center in Critical Raw Materials for Advanced Industrial Technologies Universidad de Burgos, Burgos, Spain

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Dr. Rumbo has a degree in Biology, and a PhD in Health Sciences, in the field of Microbiology. He currently coordinates the Toxicology Research Line at University of Burgos in ICCRAM. He has a strong background in the study of several fields related with nosocomial pathogens, including mechanisms of multidrug resistance, gene transfer and virulence. His main research activities are related with the analysis of the toxicity and biocompatibility of new materials and nanoparticles using human cell lines as model organisms, and in the study of the antimicrobial activity of new compounds. He is the scientific coordinator of DIAGONAL "Development and scaled Implementation of sAfe by design tools and Guidelines for multicomponent and harms Nanomaterials" and he is one of the PI of BIOTEC-GREENER Project "InteGRated systems for Effective ENvironmEntal Remediation'' and BIOSYSMO "BIOremediation systems exploiting SYnergieS for improved removal of Mixed pOllutants".

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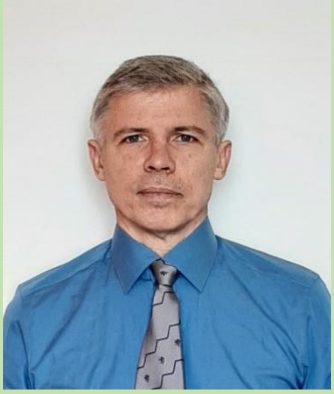
Probing biocolloids with precision: insights from Raman spectroscopy and atomic force microscopy

Andre Skirtach

Department of Biotechnology, Faculty of Bioscience Engineering, Ghent University, Ghent, Belgium

In today's scientific landscape, unravelling the complexities of biocolloids has emerged as a pressing global issue, particularly concerning their stability and utility in biotechnology and pharmaceutical applications. Thankfully, the synergy between Atomic Force Microscopy (AFM) and Raman Spectroscopy presents an elegant solution, enabling scientists to investigate biocolloids with exceptional precision and gain valuable insights into their makeup and behaviour. Raman spectroscopy will be unveiled as a powerful tool for deciphering the chemical composition of biocolloids in their natural state without additional treatments, enabling us to uncover the molecular secrets within these complex systems. Simultaneously, AFM will help us to visualise and quantify the physical characteristics of biocolloids, unravelling their topography, hardness, elasticity, and adhesive forces. Through this lecture, students will acquire a comprehensive grasp of the synergistic insights offered by Raman and AFM, thereby illuminating potential applications in fields such as biotechnology, drug delivery, and materials science.



Andre Skirtach

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Andre Skirtach was born in Ukraine and received MSc degree from Moscow State University of Lomonosov, Russia, and Ph.D. degree from McGill University, Canada. Subsequently, he joined the National Research Council of Canada (NRC) in Ottawa. In 2000, Dr. Skirtach and colleagues were involved in establishing a prominent startup—Trillium Phot., Inc. He then moved to the Max-Planck Institute of Colloids and Interfaces, Golm, Germany, first working as a researcher and then as a Group Leader. Since 2011, Dr. Skirtach has joined the Faculty of Bioscience Engineering, Ghent University, Belgium. His scientific research interests include nanotechnology and nanobiotechnology, cell biology, cell death and mechanobiology, development of microscopy and analytical methods, nanoparticles, polymeric capsules and planar interfaces, self-assembly and its applications.

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Study of the environmental fate of nanoparticles in organisms using radiotracing

Stefan Schymura

Helmholtz-Zentrum Dresden-Rossendorf, Institute of Resource Ecology, Research Site Leipzig, Leipzig, Germany

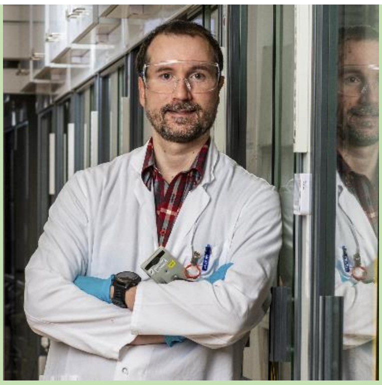
Manufactured nanoparticles, such as CeO_2, give rise to novel risks when released into the environment. To assess these risks, it is important to quantify the nanoparticle mass flows, as well as their speciation and the mechanisms of their transformation. The method of Radiotracing allows for facile, sensitive and selective detection of nanoparticles. The design and execution of a radiotracing study are shown for the example of CeO_2 uptake by water organisms. Using an innovative dual-radiolabelling strategy for CeO_2 nanoparticles uptake, transformation and excretion of CeO_2 nanoparticles in freshwater shrimp is tracked. The opportunities and challenges in conducting a radiotracing study are shown and discussed.

Dental bio-interface restoration using Ca-caseinate bio/nano colloids: a converged roughness parameter analysis via interferometric microscopy

Stefan Schymura

Helmholtz-Zentrum Dresden-Rossendorf, Institute of Resource Ecology, Research Site Leipzig, Leipzig, Germany

Chemical erosion processes can potentially demineralise the dental tooth surface, leading to permanent dental hard tissue loss, an increasing problem in modern society due to trends in acidic food consumption. This erosion can be treated using the bio/nano-colloid Ca-caseinate. The study illustrates the use of converged roughness parameters gained from interferometric microscopy to analyse the development of a reacting surface.



Stefan Schymura

Junior Research Group Leader at HZDR, Institute of Resource Ecology, Research Site Leipzig, Leipzig, Germany

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Stefan Schymura studied chemistry at the University of Stuttgart and holds Ph.D. degree in Natural Sciences from the Martin-Luther-University Halle-Wittenberg. His early research career focussed on the basic science of liquid crystalline carbon nanotube composites, while he now is involved in research concerning the environmental fate of nanoparticles. One focus of his work is the use of radiolabelling approaches for reliable detection of nanomaterials in complex media. Additionally, he has experience in the use of interferometric microscopy for the analysis of surface reactivity of materials. Currently, he is heading a junior research group tasked with nanosafety research at the Institute of Resource Ecology of HZDR at the Research Site Leipzig.

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