Nanoscale

ROYAL SOCIETY OF CHEMISTRY

EDITORIAL

View Article Online
View Journal | View Issue

Cite this: *Nanoscale*, 2025, **17**, 23760

DOI: 10.1039/d5nr90189h

rsc.li/nanoscale

Introduction to nanomedicines for crossing biological barriers

Lucie Sancey, [a] Ariane Boudier, [b,c] Elise Lepeltier, [c,d] Marie-Pierre Rols, [e] Jeanne Leblond Chain [f] and Nguyên T. K. Thanh [g,h]

We are delighted to present this *Nanoscale* themed collection aligning with the themes of the French Society of Nanomedicine's annual meeting, encompassing all nanotechnologies dedicated to health, such as diagnostics, therapy, imaging, and theranostics. This includes delivery and targeting, local and systemic administration, implants, and smart nano and microsystems.

This series is Guest Edited by Lucie Sancey, Ariane Boudier, Elise Lepeltier, Marie-Pierre Rols, Jeanne Leblond Chain and Nguyên Thi Kim Thanh, conference organisers of the 10th SFNano annual Meeting 2024.

The delivery of therapeutic agents across biological barriers remains one of the central challenges in modern nanomedicine. Numerous biological, physical and chemical barriers such as endothelium, macrophages, endosomes, mucus, surfactants, pH and enzymes are highly evolved to protect organisms from external attacks. However, these same defense mechanisms also limit the effective transport of therapeutic and imaging agents such as oligonucleotides, peptides, small anticancer molecules or contrast agents.

This themed collection on nanomedicines for crossing biological barriers, aligned with the SFNano 2024 workshop, highlights recent advances in the design, characterization, and clinical translation of nanomaterials engineered to traverse these complex interfaces. The contributions span a broad range of approaches, from lipid-based nanoparticles, polymeric carriers, inorganic nanoparticles, extracellular vesicles to bio-inspired and hybrid nanostructures. Collectively, they underscore how a mechanistic understanding of transport phenomena, coupled with innovative material science, is driving the next generation of nanotherapeutics.

The articles presented here illustrate not only the progress made in optimizing physicochemical properties to enhance permeability, but also the increasing sophistication of *in vitro* and *in vivo* models to study barrier crossing. Several contributions further emphasize the importance of immune interactions, biocompatibility, and scalable manufacturing processes: key elements that will ultimately define the success of nanomedicines in the clinic.

We believe that this collection will serve as a valuable resource for researchers across disciplines, from fundamental nanoscience to translational medicine. We hope it will stimulate new collaborations and accelerate the development of strategies to overcome biological barriers for the treatment of cancer, infectious diseases, neurological disorders, and beyond.

We warmly thank all authors and reviewers for their contributions, and the *Nanoscale* editorial team for their support in assembling this themed issue.

[a]*Institute for Advanced Biosciences, CNRS, Grenoble, France. E-mail: lucie.sancey@univ-grenoble-alpes.fr*
[b]*UMR 7274 CNRS, University of Lorraine, Nancy, France*
[c]*Institut Universitaire de France (IUF), 1 rue Descartes, 75005 Paris, France*
[d]*MINT Laboratory, INSERM 1066, CNRS 6021, University of Angers, France*
[e]*Arna Laboratory, INSERM U1212, The Institute of Pharmacology and Structural Biology, CNRS, Bordeaux, France*
[f]*IPBS-CNRS UMR 5089, University of Toulouse, Toulouse, France*
[g]*Biophysics Group, Department of Physics & Astronomy, University College London, Gower Street, London, WC1E 6BT, UK*
[h]*UCL Healthcare Biomagnetics and Nanomaterials Laboratories, 21 Albemarle Street, London, W1S 4BS. E-mail: ntk.thanh@ucl.ac.uk*

Lucie Sancey

Lucie Sancey obtained her PhD in 2006 in the field of nuclear imaging contrast agents. After a post-doctoral fellowship in optical imaging, she worked as a researcher in Lyon, developing theranostic nanoparticles for enhanced radiotherapy from lab to bed-side. She has been Director of Research of the French CNRS at the Institute for Advanced Biosciences since 2020, in Grenoble, France. Her research activities focus on the development and evaluation of innovative compounds for cancer imaging and treatment. This includes the development of nano-agents for cancer diagnosis and therapy, in particular for neutron capture therapy, new multimodal optical contrast agents for image-guided surgery and innovative elemental imaging techniques for biological tissues. She has applied for 3 patents, 2 start-ups, and published more than 115 peer review publications.

Ariane Boudier

Ariane Boudier has an education in pharmaceuticals, and she was a resident in pharmacy. She did a PhD on micelles for ex vivo *therapies at the Institut Charles Gerhardt, UMR 5253 in Montpellier. Then, she had a position as an associate professor in Nancy and obtained her position as a full professor in 2019. She teaches in physical chemistry in health, mainly in pharmacy. She is a researcher in the Laboratoire Réactions et Génie des Procédés. She is a member of the Institut Universitaire de France (IUF) with an Innovation Chair on a project on nanoclusters until 2028. She has strong expertise in inorganic nano-objects synthesis for health and more recently she is working on nanoclusters as new nanomedicines. She has applied for 3 patents and published more than 60 peer reviewed publications. She is/was involved in 3 research programs for the National Agency of Research (ANR).*

Elise Lepeltier

Elise Lepeltier is a chemist from one of the most selective and prestigious French Grandes Ecoles called "Ecole Normale Supérieure". In 2013, she defended her PhD on self-assemblies composed of nucleosidic analogues coupled with terpenoids, as an original platform for anticancer drug delivery, in an ERC project led by Prof. Patrick Couvreur and under the supervision of Dr Claudie Bourgaux (Institut Galien Paris-Sud, University Paris-Sud). She spent two years as a post-doctoral fellow in the Helmholtz Institute for Pharmaceutical Research (Saarbrücken, Germany), working on the development of innovative nanomedicines using biopolymers in the context of infectious diseases (supervised by Prof. Claus-Michael Lehr). Appointed in 2015 as an associate professor at the MINT laboratory (Translational Micro and Nanomedicines), led by Prof. Saulnier (University of Angers, France), her main objective is to design surface functionalized nanocarriers and prodrug self-assemblies for the smart delivery of anticancer compounds. In 2020, she obtained her habilitation in chemistry entitled "Surface functionalization and self-assembly: the future of nanomedicines?". In October 2023, she was appointed to the prestigious Institut Universitaire de France (IUF) for five years, as a Junior Innovation Chair. To finish, Lepeltier is the author of 48 peer-reviewed publications and 2 patents (h-index: 22 from Google Scholar, June 2025) and she has received different funding, notably two French Industrial theses "CIFRE", two projects from the French research agency called ANR and one project from the French League Against Cancer.

Marie-Pierre Rols

Marie-Pierre Rols has an education in biochemistry and biophysics. She did a PhD in cell biophysics and get a position as a junior scientist in Toulouse. In 2010, she obtained the position of senior scientist. She is currently Director of Research at the IPBS-CNRS laboratory in Toulouse, "cellular biophysics" group leader and head of the "Structural Biology and Biophysics" Department. She is a member of the board of the SFNano, ISEBTT, BES societies. Her research interests lie in the fields of membrane destabilization by pulsed electric fields leading to the electropermeabilization of cells and tissues. She is involved in different aspects including the mechanisms of cell electropermeabilization, DNA electrotransfer, as well as biomedical applications for cancer treatment and gene therapy. She has been developing for many years a multidisciplinary approach combining cell biology and biophysics. Her approach is to use various imaging tools to visualize and define these phenomena at the molecular level on models of increasing complexity: giant vesicles, cells in culture, multicellular spheroids, small animal. She has expertise in cytotoxic drugs and nucleic acids electrotransfer and has been involved in medical applications of electroporation for cancer treatment and gene therapy; she participated in clinical trials on electrochemotherapy in humans and in horses. She has also developed expertise in the effects of RF on cells and tissues, and in the combination of nanoparticles and pulsed electric fields, these last 10 years. Rols is the author of more than 200 articles in peer-reviewed journals. She has received different prizes including the Franck Reidy Prize in 2021 for outstanding achievements in bioelectrics.

Jeanne Leblond Chain

Jeanne Leblond Chain has been an associate researcher at INSERM within the laboratory ARNA in Bordeaux, France, since 2019. She leads the group of "Targeted Aptamers, Medicines and Sensing" focused on the development and therapeutic applications of aptamers and nanomedicines. Equipped with an engineering degree in organic chemistry, she obtained her PhD in the Faculty of Pharmacy at the University Paris V in France where she developed new synthetic vectors for gene therapy. She joined Prof. Leroux's team at the University of Montréal for postdoctoral studies in 2006. Then, she joined the Faculty of Pharmacy as an assistant professor in 2011 and left Montréal in 2019 as an associate professor. She directed the Gene Delivery Laboratory for 8 years, which developed stimuli-responsive systems for intracellular delivery of genes and drugs, as well as the research axis "Drug Formulation and Analysis" for 3 years. She was the secretary of the Canadian Chapter of the Controlled Release Society and has been on the board of the French Society of Nanomedicine since 2022. Her multidisciplinary background enables her to conduct research from the chemical design up to the in vivo *proof-of-concept. In her group, she is interested into supramolecular assemblies of lipids and aptamers for smart delivery systems.*

Nguyên T. K. Thanh

*Nguyên Thi Kim Thanh, MAE, FRSC, FInstP, FAPS, FIMMM FRSB (**https://www.ntk-thanh.co.uk**) held a prestigious Royal Society University Research Fellowship (2005–2014). She was appointed a full professor in nanomaterials in 2013 at University College London. She leads a very dynamic group conducting cutting-edge interdisciplinary and innovative research on the design and synthesis of magnetic and plasmonic nanomaterials, mainly for biomedical applications. In 2019, she was honoured for her achievements in the field of nanomaterials and was awarded the highly prestigious Royal Society Rosalind Franklin Medal. She was the RSC Interdisciplinary Prize winner in 2022. She was awarded SCI/RSC Colloids Groups 2023 Graham Prize Lectureship to recognise an outstanding mid-career researcher in colloid and interface science. She is one of 12 recipients globally of the 2023 Distinguished Women in Chemistry/Chemical Engineering Awards, bestowed by the International Union of Pure and Applied Chemistry (IUPAC). Currently, she is Vice Dean for Innovation and Enterprise at the Faculty of Maths and Physical Sciences. She was elected as a member of Academia Europaea in April 2024. She is Editor-in-Chief of the Royal Society of Chemistry book series, Nanoscience and Nanotechnology and an Associate Editor for Nanoscale and Nanoscale Advances. She has edited 8 themed issues including: Magnetic Nanoparticles: From Massart Method to a Cascade of Innovations (Nanoscale, RSC 2025); Design and scaling up of theragnostic nanoplatforms for health: towards translational studies (Nanoscale, RSC 2023); Theranostic nanoplatforms for biomedicine (Nanoscale, RSC 2021). She is the sole editor of two seminal books on Magnetic Nanoparticles from Fabrication to Clinical Applications and Clinical Applications of Magnetic Nanoparticles.*