

IX ANNUAL MEETING
Cinbio
Universidade de Vigo

Shaping the future:
bond by bond, cell by cell

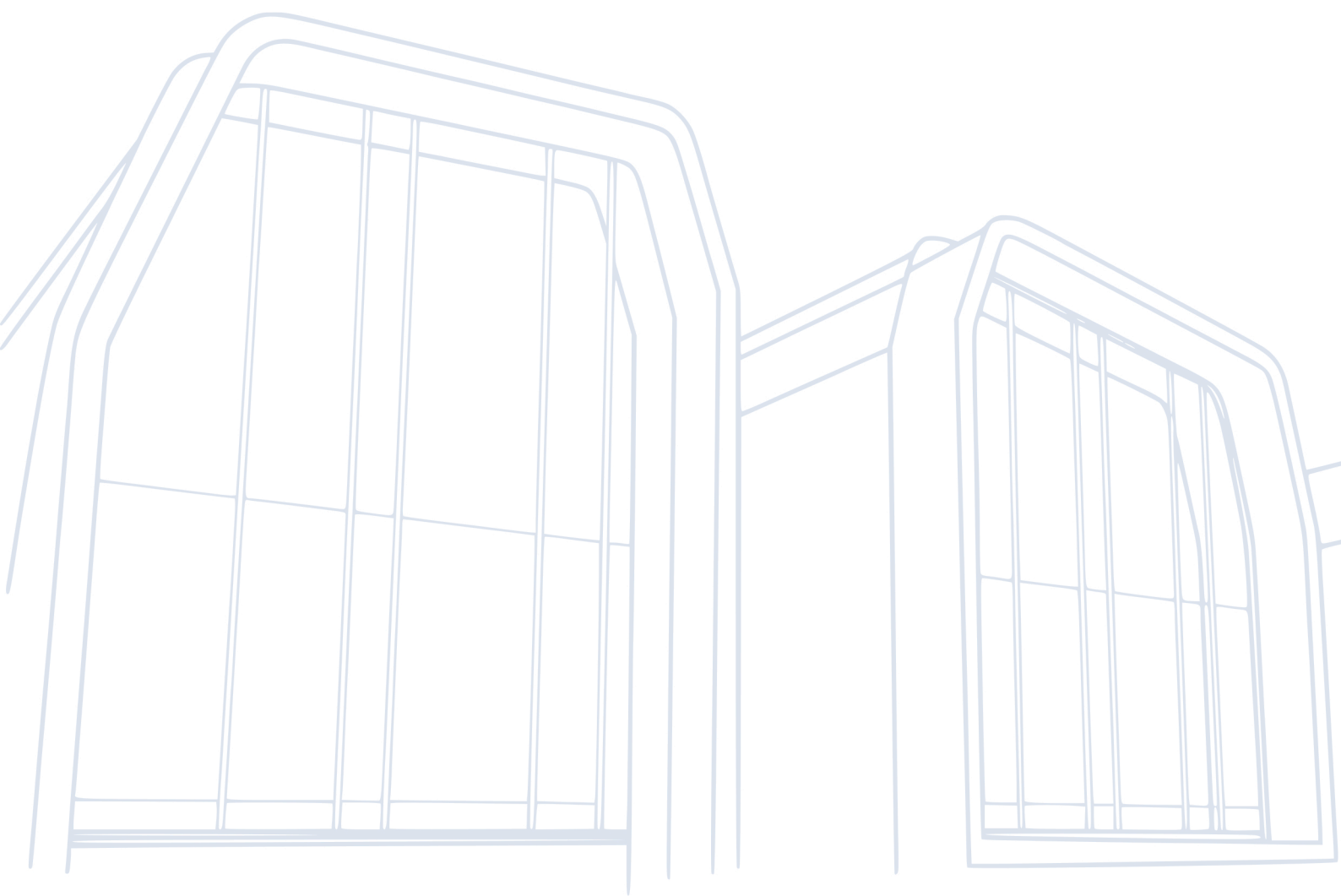
Book of Abstracts
ISBN: 978-84-09-87971-7



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Prologue

It is my great pleasure to present the Book of Abstracts of the 9th CINBIO Annual Meeting, an event that has become a distinctive hallmark of our research center and a valuable platform for scientific exchange within our community.

Since its inception in 2017, the CINBIO Annual Meeting has been entirely organized by the postdoctoral researchers of CINBIO, whose commitment, enthusiasm, and leadership have been instrumental in consolidating this initiative year after year. This ninth edition once again demonstrates the vitality, excellence, and collaborative spirit that characterize our center.

The meeting provides an outstanding opportunity for researchers at different career stages to share their latest findings, exchange ideas, establish new collaborations, and discuss emerging challenges and opportunities in the fields of nanomaterials, biomedicine, and related disciplines. The diversity and quality of the contributions collected in this volume reflect the interdisciplinary nature of CINBIO and the scientific excellence of its research community.

This book brings together the abstracts presented during the meeting and serves not only as a record of the scientific contributions shared during the conference, but also as a testament to the innovation, dedication, and talent of our researchers. The participation and engagement of all attendees contribute to strengthening our scientific environment and fostering new perspectives and collaborations.

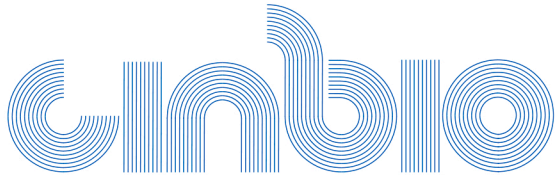
I would like to express my sincere gratitude to the organizing committee, the scientific committee, the invited speakers, and all the researchers who have contributed to this meeting. Their efforts and enthusiasm have made this ninth edition possible and continue to reinforce the success and growth of the CINBIO Annual Meeting.

I hope that this volume will serve as a valuable source of knowledge and inspiration and that the interactions established during the meeting will lead to fruitful and lasting collaborations.



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Director of CINBIO

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8:30 - 9:00 Registration
9:00 - 9:30 Opening and Welcome

SESSION 1

09:30 - 10:15 (KS1) Carlos Martí Gastaldo ICMOL, Universitat de València
Programming Adaptive Chirality in Metal–Organic Frameworks

10:15 - 10:25 (ST1) Raquel Almuíña González CINBIO, UVigo
CRISPR-Cas13d guide RNA design and validation for pro-tumorigenic gene silencing in pancreatic cancer: lipofectamine-based screening and AAV serotype evaluation

10:25 - 10:35 (ST2) Leyre Currás Barreiro CINBIO, UVigo
CPL Generation via Perovskite-Coupled Chiral Plasmonic Metasurfaces

10:35 - 10:45 (ST3) Martiño Barreiro Chapela UVigo
Effects of Caribbean (C-CTX-1) and Pacific (P-CTX-3C) ciguatoxins on striatal dopaminergic neurotransmission in rats

10:45 - 10:55 (ST4) Claudia Román Freijeiro CINBIO, UVigo
Modulating Brownian Motion and Heat Dissipation in Akaganeite-Derived Magnetic Nanoparticles via Silica Encapsulation

11:00 - 12:00 Coffee & Poster session I

SESSION 2

12:00 - 12:30 (IS1) Agustín Mihi ICMB-BCSIC, Barcelona
Nanoimprinted Chiral Photonic Architectures for Circularly Polarized Photoluminescence

12:30 - 12:40 (ST5) Cristian Alvela CINBIO, UVigo
Divergent Disruption of Autophagy and Oxidative Stress Responses in ALMS1 and BBS1 Ciliopathy Models: Evaluating Baicalin as a Potential Therapeutic

12:40 - 12:50 (ST6) Leonor Póvoa Coutinho CINBIO, UVigo
Theoretical study of the chiroptical response of chiral silver nanorod dimers

12:50 - 13:00 (ST7) Carmen Núñez González CINBIO, UVigo
Mechanisms underlying visual salience to the SNc/VTA

13:00 - 13:30 (IS2) Ferrán Nadeu Hospital Clínic, Barcelona
An evolutionary journey across the chronic lymphocytic leukemia course

13:30 - 15:00 Lunch & Networking

SESSION 3

15:00 - 15:30 (IS3) Paula Gómez Sotres IMIM, Barcelona
Olfactory bulb astrocytes link social transmission of stress to cognitive adaptation in male mice

15:30 - 15:40 (ST8) Iago López-Fernández CINBIO, UVigo
Bifunctional APTES-Based Silica Shell Growth on Perovskite Nanocrystals

15:40 - 15:50 (ST9) Ana Peredo INL
Targeted delivery of CDK4/6 inhibitors using hybrid magnetic nanoparticles in melanoma spheroids

15:50 - 16:00 (ST10) Artai Toba Pérez CINBIO, UVigo
Plasmonic supraparticles for SERS detection of water contaminants

16:00 - 16:30 Coffee break

16:30 - 17:00 (IS4) Gustavo Fernández University of Münster
(Aza)BODIPY Dye Assemblies: From Controlled Self-Assembly to Bioimaging

17:00 - 17:10 (ST11) Emma Alonso Pérez IISG
Exploring HPV ctDNA and immune profiling for disease monitoring in cervical cancer patients

17:10 - 17:20 (ST12) Maedeh Anisi CINBIO, UVigo
Chirality Engineering of Covalent Organic Frameworks for Electrochemical Water Oxidation

17:20 - 17:30 (ST13) Alexander Carneiro Figueira CINBIO, UVigo
A Functional Screening Platform to Test Therapy Response in Sarcoma Patient-Derived Models

9:00 - 9:15 Opening

SESSION 1

9:15 - 10:00 (KS2) Juan José Lasarte CIMA
Outside the Box, Inside the Stroma: Targeting Non-Tumor Antigens and Metabolic Barriers to Boost CAR-T Therapy

10:00 - 10:10 (ST14) Fábio Alberto Costas Lopes CF-UM-UP, University of Minho
Magnetoplasmonic Liposomes: A Multi-Technique Journey into Their Structure and Properties

10:10 - 10:20 (ST15) Brais Vidal CINBIO, UVigo
Exploring Polyene Construction Tactics for the Total Synthesis of Ocular Pyridinium Bisretinoids of Lipofuscin A2E and pdA2E

10:20 - 10:30 (ST16) Helena Landín CIQUS, USC
Dynamic Chiral Metallo-Supramolecular Polymers

10:30 - 11:00 (IS5) Fiona Freeman University of Dublin
Engineering Complex Bone Tumour Models: Unravelling Tumour Microenvironment for Drug Discovery

11:00 - 12:00 Coffee & Poster session II

SESSION 2

12:00 - 12:30 (IS6) Mónica Giménez ICMOL, Universitat de València
Engineering biohybrid porous structures at the nanoscale for advanced functionalities

12:30 - 12:40 (ST17) Iñaki López Díaz CINBIO, UVigo
Senotherapeutic peptides targeting the C-terminal domain of Cx43 facilitate a pro-regenerative environment and provide a targeted therapy to prevent osteoarthritis progression

12:40 - 12:50 (ST18) Leonor Franqueira CF-UM-UP, University of Minho
Chitosan-agarose gels containing niosomes for controlled drug release

12:50 - 13:00 (ST19) Antía Álvarez Pazó CINBIO, UVigo
MOF-Templated COF Nanostructures for Biosensing Applications

13:00 - 13:10 (ST20) Susana Gomes iMATUS, IDIS
Synergistic communication mechanism: double step sergeants and soldiers effect

13:10 - 13:40 ROUNDTABLE

Paula Carpintero - CETIM
Cecilia Marino Cabaleiro - Zendal
Celina Costas - CINBIO, UVigo & CIC biomaGUNE

13:40 - 14:00 Prizes and Closing Remarks

(KS) Keynote speaker (IS) Invited speaker (ST Short Talk)



TABLE OF CONTENT

❖ ORAL COMMUNICATIONS

Invited Speakers

KS1 -Programming Adaptive Chirality in Metal–Organic Framework	1
KS2 -Outside the Box, Inside the Stroma: Targeting Non-Tumor Antigens and Metabolic Barriers to Boost CAR-T Therapy	2
IS1 -Nanoimprinted Chiral Photonic Architectures for Circularly Polarized Photoluminescence	3
IS2 -An evolutionary journey across the chronic lymphocytic leukemia course	4
IS3 -Olfactory bulb astrocytes link social transmission of stress to cognitive adaptation in male mice	5
IS4 -(Aza)BODIPY Dye Assemblies: From Controlled Self-Assembly to Bioimaging	6
IS5 -Engineering Complex Bone Tumour Models: Unravelling Tumour Microenvironment for Drug Discovery	7
IS6 -Engineering biohybrid porous structures at the nanoscale for advanced functionalities	8

Short talks

ST1 : CRISPR-Cas13d guide RNA design and validation for pro-tumorigenic gene silencing in pancreatic cancer: lipofectamine-based screening and AAV serotype evaluation	10
ST2 : CPL Generation via Perovskite-Coupled Chiral Plasmonic Metasurfaces	11
ST3 : Effects of Caribbean (C-CTX-1) and Pacific (P-CTX-3C) ciguatoxins on striatal dopaminergic neurotransmission in rats	12
ST4 : Modulating Brownian Motion and Heat Dissipation in Akaganeite-Derived Magnetic Nanoparticles <i>via</i> Silica Encapsulation	13
ST5 : Divergent Disruption of Autophagy and Oxidative Stress Responses in ALMS1 and BBS1 Ciliopathy Models: Evaluating Baicalin as a Potential Therapeutic.....	14
ST6 : Theoretical study of the chiroptical response of chiral silver nanorod dimers	15
ST7 : Mechanisms underlying visual salience to the SNc/VTa.....	16
ST8 : Bifunctional APTES-Based Silica Shell Growth on Perovskite Nanocrystals	17
ST9 : Targeted delivery of CDK4/6 inhibitors using hybrid magnetic nanoparticles in melanoma spheroids.....	18
ST10 : Plasmonic supraparticles for SERS detection of water contaminants	19
ST11 : Exploring HPV ctDNA and immune profiling for disease monitoring in cervical cancer patients.....	20
ST12 : Chirality Engineering of Covalent Organic Frameworks for Electrochemical Water Oxidation	21
ST13 : A Functional Screening Platform to Test Therapy Response in Sarcoma Patient-Derived Models	22
ST14 : Magnetoplasmonic Liposomes: A Multi-Technique Journey into Their Structure and Properties.....	23
ST15 : Stereochemical Reassignment by Total Synthesis of an Ocular Pyridinium Bisretinoid of Retinal Pigment Epithelium Lipofuscin: <i>iso</i> -A2E Is <i>i</i> -A2E	24
ST16 : Dynamic Chiral Metallo-Supramolecular Polymers	25
ST17 : Senotherapeutic peptides targeting the C-terminal domain of Cx43 facilitate a pro-regenerative environment and provide a targeted therapy to prevent osteoarthritis progression	26
ST18 : Chitosan-agarose gels containing niosomes for controlled drug release	27
ST19 : MOF-Templated COF Nanostructures for Biosensing Applications	28
ST20 : Aerogel Particles for Advanced Pulmonary Drug Delivery Applications	29

❖ POSTERS

Poster Session I

PS-01: Unravelling Antenna Behavior in Porphyrin Hydrogen-Bonded Organic Frameworks: A TD-DFT and FRET Study	31
PS-02: Short-term effects of micro- and nanoplastics and their mixture with glyphosate on dopaminergic neurotransmission in striatal and cortical homogenates of rat brain	32
PS-03: Structural optimization and post-synthetic modification of a 3D covalent organic framework for gas adsorption	33
PS-04: Microwave-assisted extraction of the green seaweed <i>Ulva spp.</i> in different extraction cycles using eutectic mixtures	34
PS-05: Metal cation inducing dimensional engineering of Perovskite Nanocrystal towards chiral superstructure	35
PS-06: Coestimation of recombination and substitution rates from protein sequences integrating structural constraints.....	36
PS-07: Planar chirality as chiral source to create dynamic helical polymers	37
PS-08: Ultrasound spray-drying microencapsulation of gram-negative bacteria using composite polysaccharidic matrices	38
PS-09: Shrimp shells to prevent ocular pathologies	39
PS-10: In situ monitoring and protection of cell oxidative stress by SERS	40
PS-11: Control of Dynamic Chiral Properties in Helical Poly(diphenylacetylene) Derivatives upon Photoirradiation.	41
PS-12: Absorption and scattering in chiral gold nanoparticles.....	42
PS-13: Early Detection of Bardet-Biedl Syndrome in South America: A Knowledge-Transfer Kit for Primary Care.	43
PS-14: Characterisation of epigenetic regulation on the immunogenicity of ccRCC	44
PS-15: Recovery of Bioactive Compounds and Biopolymers from <i>Limnospira platensis</i> for Cosmetic and Nutraceutical Applications.....	45
PS-16: Molecular evolution of the Crimean–Congo hemorrhagic fever virus.....	46
PS-17: Influence of magnetite coating morphology on the transport dynamics of magnetic nanostructures.....	47
PS-18: Reversible halochromic capacity of anthocyanins immobilized within alginate fibres.....	48
PS-19: Nucleus Accumbens astrocyte modulation of feeding.....	49
PS-20: <i>Ulva stenophylloides</i> (Ulvophyceae, Chlorophyta) as a source of hemagglutinating proteins with biotechnological potential: utilization of biomass from green tides.....	50
PS-21: Development and Characterization of a 3D Bacteria-Associated Tumor Spheroid Model	51
PS-22: Characterization of reciprocal connectivity between the nucleus accumbens and the hypothalamus	52
PS-23: Computational Analysis of HIV-1 Capsid Resistance to Lenacapavir	53
PS-24: Microcalorimetric study of the growth of <i>Pediococcus pentosaceus</i> in an enriched culture medium.....	54
PS-25: Sustainable Bioactive Compounds Derived from Microalgae and Cyanobacteria for Cosmeceutical and Nutraceutical Applications (SMACC+).....	55
PS-26: Thermally Controlled Chiral Supramolecular Polymorphism in Water	56
PS-27: Addressing Pulmonary Barriers with Hyaluronic Acid Nanoparticles	57

PS-28: <i>In situ</i> formation of core-shell NPs Fe ₃ O ₄ @HgS for Hg enrichment in environmental water samples and quantification by a direct mercury analyzer	58
PS-29: Single-Particle Stokes Analysis of Isotropic and Anisotropic Chiral Gold Nanoparticles.....	59
PS-30: Optimization of plasmid DNA cloning for the study of the INTU gene	60

Poster Session II

PSII-01: SERS detection of emerging contaminants in water	62
PSII-02: Theranostic Carbon Probes from non-conventional Marine Sources; Development and Validation	63
PSII-03: α-BCL6 nanoparticles for intracellular delivery in lymphoma treatment.	64
PSII-04: COP/AuNP Platform for SERS-Based Detection of Saxitoxin.....	65
PSII-05: Chiral Covalent Organic Frameworks as Catalyst Supports for the Oxygen Evolution Reaction	66
PSII-06: Efficient Adsorption of Fluoroquinolone Antibiotics from Water by a Covalent Organic Framework.....	67
PSII-07: Mixed-Linker Strategy for Pore Surface Tuning of Covalent Organic Frameworks.....	68
PSII-08: Ag@PS-Decorated Nanofibers for Ultra-Sensitive Antibiotic Detection in Water	69
PSII-09: Context-Dependent Neurotoxicity of Medicinal Plant Phytochemicals via Convergent CNS Signaling Pathways.....	70
PSII-10: Stereoselective synthesis of decalpenic acid, a natural RARg agonist	71
PSII-11: Probabilistic Dietary Risk Assessment of Mercury, Cadmium and Arsenic from Tuna Consumption in Portuguese and Spanish Adults	72
PSII-12: Neural mechanisms for stabilizing and goal-oriented eye movements in lampreys	73
PSII-13: Establishing mechanistic relationships of adaptogens by analyzing molecular pathways and bioactivity patterns using a database	74
PSII-14: Development of Nanoengineered Strategies to Cross the Blood-Brain Barrier for Alzheimer's Disease Therapy	75
PSII-15: Polymer-modified mesoporous silica nanoparticles for targeted intestinal delivery of entinostat	76
PSII-16: Supramolecular Polymers Based on Asymmetrically Substituted Allene-based building blocks.....	77
PSII-17: Toward predictive and controllable T-cell activation models: identifiability and sensitivity analysis	78
PSII-18: Ruthenium(II) <i>p</i> -cymene-Thiosemicarbazone complexes as Potential Agents against Triple-Negative Breast Cancer	79
PSII-19: Uncovering early joint disease biomarkers through synovial fluid extracellular vesicle subpopulation analysis.....	80
PSII-20: Dual Antitumour and Immunomodulatory Activity of a Novel Target in Triple-Negative Breast Cancer	81
PSII-21: Identification and Analysis of CAR-T Cell Therapy Models	82
PSII-22: Phenolic-rich extracts from Camellia Flowers and Chestnut Shells: potential active ingredients for topical applications	83
PSII-23: Connexin 43–Enriched Extracellular Vesicles as a Therapeutic Platform with Enhanced Uptake and Antitumour Activity	84
PSII-24: Remote Control System for Mineral-Medicinal Waters Using Artificial Intelligence (AQUAPRED)	85
PSII-25: Viral infections accelerate host aging.....	86

PS_{II}-26: Generalized Additive Models for Atrial Fibrillation Detection in ECG Signals	87
PS_{II}-27: Microfluidic Fabrication of Nanostructured Hydrogel Microfibers Recreating Tendon Anisotropic Architecture and Cellular Patterns	88
PS_{II}-28: Characterization of Pressurized Hot Water Extraction of Bioactive Compounds from Mediterranean Seaweeds: <i>Chaetomorpha linum</i> and <i>Pterocladia capillacea</i>	89

INVITED SPEAKERS

Programming Adaptive Chirality in Metal–Organic Framework

Martí Gastaldo, Carlos^{1,*}

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Metal–organic frameworks provide a powerful platform to encode molecular information into crystalline porous materials, yet the design of chiral MOFs often remains dominated by static stereogenic environments. This contrasts with biological recognition, where molecular discrimination emerges from the interplay between chirality, conformational flexibility and adaptive host-guest interactions. In this lecture, I will discuss how amino acid and peptide chemistry can be used to program this coupling in reticular frameworks, creating porous crystals in which chirality is not only present, but dynamically expressed through local and collective structural response.

Our approach combines two complementary strategies. In postsynthetically modified UiO-68 frameworks, click-enabled grafting of amino acid-derived peptidic fragments creates confined chiral pockets while preserving crystallinity and porosity. Variation of the amino acid side chain shows that enantioselective recognition is not simply dictated by the presence of a stereogenic unit, but by the ability of the local pore environment to reorganize around a specific guest.^[1] Extending this principle from local pore functionalization to the framework backbone, bispyrazolate peptide linkers enable the construction of frameworks in which conformationally flexible peptide units are integrated into rod-type metal–pyrazolate secondary building units. In these materials, side-chain chemistry controls framework dimensionality, pore shape and solvent-induced transformations, giving access to adaptive responses ranging from reversible reopening to selective switching.^[2]

References:

- [1] G. Gómez-Tenés, A. Misturini, N. Almora-Barrios, S. Tatay, N. M. Padial, C. Martí-Gastaldo, J. Am. Chem. Soc. 2026, 148, 2096.
- [2] V. Carratalá, A. Misturini, M. D. F. Diouf, R. Vismara, A. Lamas, M. Gemmi, N. M. Padial, C. Martí-Gastaldo, Chem 2026, 102992.

Outside the Box, Inside the Stroma: Targeting Non-Tumor Antigens and Metabolic Barriers to Boost CAR-T Therapy

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Over the past decade, the rapid advancement of immunotherapy, particularly adoptive cell therapy, has represented a major breakthrough in the treatment of various hematological malignancies. However, translating this clinical success to solid tumors remains a formidable challenge. The action of the immune system is severely hindered by a hostile microenvironment characterized by a complex extracellular matrix, aberrant vasculature, oxygen deprivation, tissue acidification, and nutrient depletion. In addition to these physical and metabolic barriers, high tumor heterogeneity poses a significant hurdle for the development of targeted immunotherapies.

In this talk, we will explore "outside the box" alternatives in the search for novel antigens, focusing on cellular stress as an antigenic source and examining the extracellular matrix components shared across multiple tumor types. Furthermore, we will discuss genetic modification strategies designed to engineer lymphocytes capable of surviving in these acidic, nutrient-deprived environments. Finally, we will analyze the composition of the tumor interstitial fluid as an additional driver of immunosuppression and evaluate prospective therapeutic alternatives. Ultimately, these innovative modifications could bridge the gap, turning the application of cellular therapies for solid tumors into a clinical reality.

Nanoimprinted Chiral Photonic Architectures for Circularly Polarized Photoluminescence

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Soft nanoimprinting lithography (soft NIL) is a versatile, rapid, and cost-efficient method for crafting nanostructures from a diverse variety of materials. In soft NIL, we make use of pre-patterned soft elastomeric stamps to fabricate photonic structures out of materials such as resists, biopolymers, colloids and nanomaterials in general. In all cases, the resulting photonic architectures can exhibit a resolution below 100 nm while covering areas up to 1 cm².

During this presentation, I will demonstrate our utilization of pre-patterned stamps to induce the long-range alignment of different colloids, including metal colloids and perovskite nanocrystals, to attain distinct optical properties, such as lattice resonances with high Q-factors. Moreover, I will showcase how elastomeric molds pre-patterned with chiral motifs can lead to chiral 2D arrays, exhibiting strong circular dichroism and intense circularly polarized photoluminescence (CPL) combined with a wide range of emitters, making them seamlessly applicable in various practical applications.

An evolutionary journey across the chronic lymphocytic leukemia course

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Chronic lymphocytic leukemia (CLL) is a malignancy of CD5+ B cells, the most common adult leukemia in Western countries, incurable, and characterized by a high biological and clinical heterogeneity. CLL is also a unique model that allows to study cancer from an evolutionary perspective. Increasing evidence suggests that CLL may originate from oligo- or multiclonal expansions, seeding multiple, potentially independent leukemic clones. Despite this initial diversity, most patients ultimately show dominance of a single clone, which drives disease progression and underlies the clinical diagnosis. After diagnosis, the clinical course varies widely. Some patients experience indolent, stable disease for years, whereas others show rapid progression requiring early treatment. In 5-10% of cases, CLL transforms into an aggressive lymphoma, usually diffuse large B-cell lymphoma, a process known as Richter transformation, conferring a dismal prognosis. This talk will explore how single cell genomics –including targeted single-cell DNA-seq, single-cell whole genome sequencing, and single-cell RNA-seq– provides new insights into the origin and evolutionary trajectories of CLL.

Olfactory bulb astrocytes link social transmission of stress to cognitive adaptation in male mice

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Emotions and behavior can be affected by social chemosignals from conspecifics. For instance, olfactory signals from stressed individuals induce stress-like physiological and synaptic changes in naïve partners. Direct stress also alters cognition, but the impact of socially transmitted stress on memory processes is currently unknown. Our research shows that exposure to chemosignals produced by stressed individuals is sufficient to impair memory retrieval in unstressed male mice. This requires astrocyte control of information in the olfactory bulb mediated by mitochondria-associated CB1 receptors (mtCB1). Targeted genetic manipulations, in vivo Ca²⁺ imaging and behavioral analyses reveal that mtCB1-dependent control of mitochondrial Ca²⁺ dynamics is necessary to process olfactory information from stressed partners and to define their cognitive consequences. Thus, olfactory bulb astrocytes provide a link between social odors and their behavioral meaning.

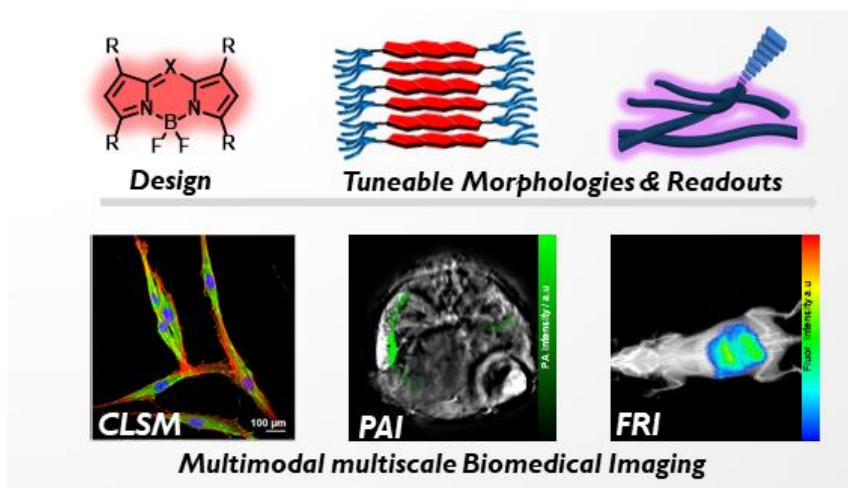
(Aza)BODIPY Dye Assemblies: From Controlled Self-Assembly to Bioimaging

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Supramolecular self-assembly offers a powerful bottom-up strategy to engineer functional nanostructures with emergent optical and biomedical properties.¹ In this context, (aza)BODIPY dyes constitute a versatile platform owing to their outstanding photophysical properties, synthetic modularity and chemical robustness.² While BODIPYs have traditionally been studied as molecular fluorophores, our work has established their self-assembly in solution as a versatile platform to control supramolecular packing, excitonic coupling, aggregate morphology, and emergent function across multiple length scales.³ In this lecture, I will present our recent advances in the controlled self-assembly of BODIPY-based systems,³ with particular emphasis on the interplay between molecular design, supramolecular organization, aggregate morphology, and emergent biomedical function (Scheme 1).⁴ Illustrative examples will demonstrate the potential of these assemblies for multimodal bioimaging applications at the interface of supramolecular chemistry, photonics, and biomedicine.



Scheme 1. Molecular design-aided BODIPY self-assembly towards controlled bioimaging functions.

References:

- [1] Antonia Albers, Max Masthoff, Gustavo Fernández, *Angew. Chem. Int. Ed.* 2026, e25491.
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- [3] (a) Z. Fernández, M. Parashar, R. M. Veedu, S. Baumert, L. Rubert, B. Soberats, S. Balasubramanian, G. Fernández, *Angew. Chem. Int. Ed.* 2025, e202520168; (b) A. Albers, S. Baumert, C. G. Daniliuc, G. Fernández, *ChemistryEurope* 2025, e202500253; (c) R. M. Veedu, N. Niemeyer, N. Bäumer, K. K. Kalathil, J. Neugebauer, G. Fernández, *Angew. Chem. Int. Ed.* 2023, e202314211; (d) B. Matarranz, S. Díaz-Cabrera, G. Ghosh, I. Carreira-Barral, B. Soberats, M. García-Valverde, R. Quesada, G. Fernandez, *Angew. Chem. Int. Ed.* 2023, e202218555; (e) I. Helmers, M. S. Hossain, N. Bäumer, P. Wesarg, B. Soberats, L. S. Shimizu, G. Fernández, *Angew. Chem. Int. Ed.* 2022, e202200390; (f) I. Helmers, G. Ghosh, R. Q. Albuquerque, G. Fernández, *Angew. Chem. Int. Ed.* 2021, 60, 4368-4376.
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Engineering Complex Bone Tumour Models: Unravelling Tumour Microenvironment for Drug Discovery

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Osteosarcoma, a highly aggressive bone cancer primarily affecting children, adolescents, and young adults, remains one of the most challenging paediatric cancers to treat. Despite advances in cancer research, the standard-of-care treatment for osteosarcoma has remained largely unchanged for nearly 50 years. The prognosis for patients with secondary lung metastasis is particularly poor, with approximately 70% succumbing to the disease within three years. Compounding this issue, osteosarcoma's rarity significantly limits the recruitment of eligible participants for clinical trials, further delaying the development of effective treatments.

Traditional 2D cell cultures have long been the primary in vitro model used in cancer research. While these models are cost-effective and relatively straightforward to produce and maintain, they fall short in replicating the solid tumour characteristics and complex interactions between tumour cells and their surrounding microenvironment. This disconnect has contributed to the high failure rate of preclinical drug candidates in clinical settings, emphasizing the urgent need for more representative in vitro models.

Emerging research has highlighted the potential of advanced 3D models in bridging this gap. These models more accurately mimic the phenotypic behaviour of primary tumours, particularly in sarcomas like osteosarcoma, where growth rates, cell morphology, cell-cell junctions, and kinase activation in spheroids exhibit remarkable similarity to their in vivo counterparts. Developing such models has become essential for unravelling the complexities of osteosarcoma progression and identifying novel therapeutic targets.

This presentation will explore the innovative osteosarcoma models developed in our laboratory to address these challenges. By recreating the intricate interplay between osteosarcoma cells and key components of the tumour microenvironment, our models aim to provide deeper insights into disease mechanisms and progression. Additionally, we will discuss how these models are being utilized to evaluate and accelerate the development of novel therapeutic strategies, with the ultimate goal of improving outcomes for patients facing this devastating disease.

Through this work, we aim to contribute to a paradigm shift in osteosarcoma research, highlighting the critical role of advanced in vitro models in overcoming longstanding barriers in translational cancer research.

Engineering biohybrid porous structures at the nanoscale for advanced functionalities

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Hybrid nanostructures with specific composition and arrangement represent an important source of materials for advanced functionalities. Such useful structural diversity can be gathered at the nanoscale by assembly of molecular constituents with intrinsic complexity such as metal-organic frameworks, or by combination with other nanoparticles or biomolecules. This versatile, bottom-up chemistry has led to a variety of MOF-based hybrids with tailored chemical composition and hierarchical organization.

The specific features of these hybrid nanostructures make them very promising architectures to advances in biotechnological or biomedical uses. As an example, the integration of biomacromolecules within MOFs has proved convenient to stabilize fragile biological entities allowing triggered release and retaining their activity after exposure to denaturing environments.^[1] This process, often achieved through biomolecule-driven MOF mineralization, relies on mild synthetic conditions and favorable biomolecule–MOF interfacial interactions. The resulting frameworks not only broaden the structural diversity of biohybrids but also unveil previously inaccessible functionalities arising from their distinct compositions and architectures.

In this contribution, we will cover the detailed synthetic strategy and proposed mechanism in the formation of representative MOF-biomolecule biohybrid structures. We will discuss the interaction at the interface between host and guest with the aim to rationalise the superior performances observed in the biohybrids as compared to their individual constituents.^[2-4] This contribution highlights the importance of framework diversification as a pathway to tailor hierarchical organization and unlock novel properties in biomolecule–MOF nanohybrids.

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SHORT TALKS

CRISPR-Cas13d guide RNA design and validation for pro-tumorigenic gene silencing in pancreatic cancer: lipofectamine-based screening and AAV serotype evaluation

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Pancreatic ductal adenocarcinoma (PDAC) is one of the most lethal solid tumors, driven in part by the aberrant activity of pro-tumorigenic effectors such as YAP1, FOSL1, and DDR1 [1,2]. CRISPR-Cas13d (CasRx), a type VI RNA-targeting CRISPR effector, enables programmable post-transcriptional gene silencing without permanent genomic alterations [3]. Our goal is to develop a CasRx-based silencing strategy for these targets in PDAC delivered via adeno-associated virus (AAV), requiring two key steps: (1) identifying the most efficient guide RNAs (crRNAs) per target, and (2) selecting the optimal AAV serotype for PDAC transduction, so that validated crRNAs and the Cas13d sequence can be packaged into a single AAV construct.

crRNA candidates were first designed in silico using specialized bioinformatics tools. To screen crRNA efficiency independently of viral delivery, transient co-transfections were performed in PDAC cell lines using Lipofectamine RNAiMAX with chemically modified crRNAs and in vitro transcribed Cas13d mRNA [4]. Knockdown efficiency was assessed at 48 h post-transfection by Western blot. Screening identified target-specific optimal crRNA combinations, achieving efficient knockdown of YAP1, FOSL1, and DDR1 across PDAC cell lines.

In parallel, we evaluated the transduction efficiency of three AAV serotypes in the same PDAC cell lines. Viral particles carrying a GFP reporter under a ubiquitous promoter were applied at equivalent genomic titers (vg/cell) and quantified at 48 h post-infection by fluorescence microscopy and flow cytometry. Differential tropism was observed across serotypes and cell lines, enabling rational selection of the most efficient serotype for downstream CasRx construct packaging.

These results provide a validated crRNA library for CasRx-mediated silencing of YAP1, FOSL1, and DDR1 in PDAC and identify the optimal AAV serotype for efficient delivery, laying the groundwork for a stable all-in-one AAV-CasRx system for in vitro and future in vivo applications.

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CPL Generation via Perovskite-Coupled Chiral Plasmonic Metasurfaces

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Chiral nanocrystals are emerging as versatile platforms for optical and optoelectronic phenomena. In parallel, chiral plasmonic nanoparticles have gained attention in recent years as highly promising building blocks for applications in sensing, optoelectronics and nanophotonics. Enhancing circularly polarized luminescence (CPL) through plasmonic coupling is a central goal in chiral photonics and optoelectronics¹. Here, we demonstrate a perovskite–plasmonic hybrid platform that enables CPL amplification. CsPbBr₃-based perovskite thin films were deposited by spin coating onto chiral plasmonic substrates, including gold nanostructures and nanoimprinted metasurfaces. Under optical excitation, the chiral gold nanostructure hybrid system exhibited CPL, with a dissymmetry factor (g_{lum}) on the order of 0.01. To further enhance the chiral optical response, we engineered more complex chiral plasmonic architectures using triskelion-shaped metasurfaces and integrated the perovskite semiconductor onto these platforms. This structural optimization resulted in an approximately one order of magnitude increase in the photoluminescence dissymmetry factor. Silver metasurfaces achieved g_{lum} values of up to 0.1, demonstrating efficient near-field transfer of optical chirality and highlighting the role of plasmonic mode matching in CPL amplification. Taken together, these results demonstrate that hybrid plasmon–perovskite architectures constitute a powerful and tunable strategy for engineering spin-selective optical responses. This approach establishes clear design principles for the development of efficient circularly polarized light sources, polarization-selective photonic components and next-generation chiral optoelectronic devices.

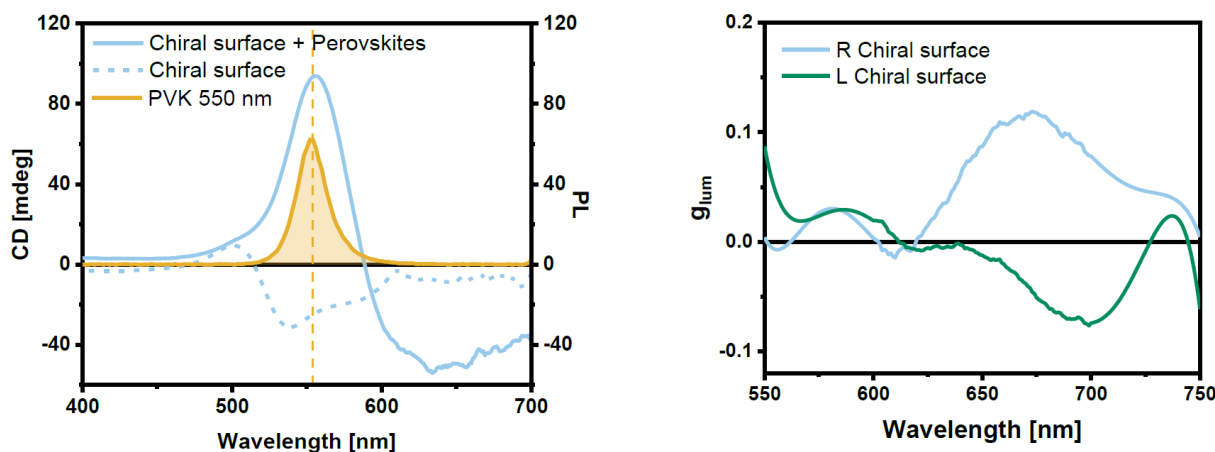


Figure 1 (a) CD spectra of chiral gold substrates before and after spin-coated perovskite deposition. (b) g_{lum} spectra of chiral silver metasurfaces with an ALD- Al_2O_3 layer after deposition of a 658 nm CsPbBr₃.

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Effects of Caribbean (C-CTX-1) and Pacific (P-CTX-3C) ciguatoxins on striatal dopaminergic neurotransmission in rats

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Introduction: Ciguatera fish poisoning represents the most widespread intoxication caused by marine toxins worldwide [1]. It results from the consumption of fish contaminated with ciguatoxins (CTXs), which are predominantly found in tropical regions such as the Caribbean Sea, the Pacific Ocean, and the Indian Ocean [2]. Ongoing climate change is facilitating the expansion of CTX-producing dinoflagellates into new geographical areas, increasing concerns regarding food safety. The clinical manifestations of ciguatera are closely linked to the molecular action of CTXs, which bind with high affinity to several subtypes of voltage-gated sodium channels, including those expressed in the central nervous system [2].

Objetives: To assess and compare the impact of Caribbean ciguatoxin C-CTX-1 and Pacific ciguatoxin P-CTX-3C on extracellular dopamine and on the levels of its acidic metabolites, DOPAC and HVA, in the rat striatum.

Materials and Methods: Female Sprague–Dawley rats received an intraperitoneal injection of either C-CTX-1 or P-CTX-3C at a dose of 1.5 ng/kg (n = 5-6 per group). Extracellular samples were obtained by in vivo brain microdialysis in conscious, freely moving animals. Dopamine, DOPAC, and HVA concentrations were determined using high-performance liquid chromatography coupled to electrochemical detection (HPLC-ED).

Results: Administration of both ciguatoxins induced a marked reduction in extracellular dopamine levels, which decreased to 42.2% of baseline after C-CTX-1 and to 46.1% after P-CTX-3C treatment. In parallel, dopamine metabolism was enhanced, as evidenced by increased DOPAC and HVA concentrations. Following C-CTX-1 injection, DOPAC and HVA levels rose to 126% and 122.1% of baseline, respectively, whereas P-CTX-3C administration led to a stronger increase, reaching 168.9% for DOPAC and 165.4% for HVA.

Conclusions: These findings indicate that both C-CTX-1 and P-CTX-3C significantly disrupt dopaminergic neurotransmission in the rat striatum by decreasing extracellular dopamine levels and simultaneously enhancing its catabolic pathways.

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Modulating Brownian Motion and Heat Dissipation in Akaganeite-Derived Magnetic Nanoparticles *via* Silica Encapsulation

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Akaganeite (β -FeOOH) is a tunnel-structured iron oxyhydroxide that has attracted increasing interest across various scientific fields due to its high surface-to-volume ratio and enhanced reactivity, making it relevant for environmental, catalytic, and energy storage applications.^[1] In the latter field, understanding the Brownian motion of the nanoparticles is of crucial importance, as it directly influences energy storage capacity. Specifically, applications utilizing nanoparticles in suspension aim to maximize Brownian motion to achieve rapid and efficient thermal exchange. Given that Brownian motion is a critical mechanism for drastically increasing heat transfer, its optimization is key to enhancing both cooling and heating processes.^[2]

Within this framework, this study focuses on tuning the morphology and magnetic properties of these nanoparticles. To modify the magnetic properties of elongated akaganeite nanoparticles, a reduction process is performed using oleylamine, to obtain magnetite/akaganeite nanoparticles while preserving their morphology. This modification endorses the nanoparticles with a magnetic moment, which responds to the influence of a magnetic field and magnetic field gradient, promoting their directed motion.

Alternatively, the nanoparticles can be coated with an outer thin or thick silica shell, which affects their Brownian and/or directed motion. In both cases, the dynamics can be checked by Mean Squared Displacement (MSD) analysis, with the MSD plots obtained through the analysis of optical microscopy video recordings employing software such as ImageJ and MATLAB.

Finally, to evaluate the influence of the silica shell on the heat dissipation of the magnetic nanoparticles, magnetic hyperthermia experiments are conducted on three samples: the uncoated nanoparticles and both silica-coated variants. ^[3]

Acknowledgements

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Divergent Disruption of Autophagy and Oxidative Stress Responses in ALMS1 and BBS1 Ciliopathy Models: Evaluating Baicalin as a Potential Therapeutic

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Primary cilia are critical sensory organelles that regulate cellular signalling and homeostasis. Mutations in ciliary genes lead to multisystemic disorders known as ciliopathies, including Alström Syndrome (ALMS1) [1] and Bardet-Biedl Syndrome (BBS1) [2]. This study investigates how defects in these specific genes alter autophagic flux and the cellular stress response and evaluates the potential of the natural flavonoid baicalin as treatment. We utilized immortalized human fibroblasts (hTERT-BJ-5ta), comparing WT with BBS1 and ALMS1 Knock-out cell lines. To assess its therapeutic viability and mechanism, cells were treated with baicalin, alongside bafilomycin A1 to monitor lysosomal degradation [3]. Protein expression for autophagic markers (LC3B, p62) and transcriptional responses (SQSTM1, NFE2L2, HMOX1) were measured.

Our results reveal that the ALMS1 KO model demonstrates intact bulk autophagy but a severe defect in selective autophagy, evidenced by massive p62 protein accumulation. This buildup triggers the non-canonical p62-KEAP1-NRF2 pathway, leading to chronic overexpression of the antioxidant enzyme HMOX-1. In contrast, the BBS1 KO model exhibited a profound global suppression of the NRF2 antioxidant axis, with deeply depressed levels of p62, NRF2, and HMOX-1. Crucially, regarding the therapeutic evaluation, baicalin successfully stimulated autophagic flux and partially reduced p62 accumulation in ALMS1 KO cells, demonstrating that the drug's mechanism of action remains functionally viable in this genotype. In stark contrast, BBS1 KO fibroblasts were completely refractory to baicalin, showing no improvement in autophagic flux or antioxidant expression, suggesting that the BBSome complex is essential for baicalin's mechanism of action, likely acting as a required intermediary in the ciliary signalling needed to inhibit mTOR and induce autophagy. These results demonstrate that the therapeutic efficacy of baicalin is genotype-dependent and requires a functional BBSome, highlighting the primary cilium as a decisive factor in the pharmacological modulation of cellular proteostasis.

Acknowledgements

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Theoretical study of the chiroptical response of chiral silver nanorod dimers

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Plasmonic nanostructures couple strongly with light, and chiral plasmonic nanostructures produce strongly differential responses to circularly polarized light (CPL) of different handedness, much more so than those of chiral molecules, so that they are excellent systems to study chiral light-matter interaction in the nanoscale. Such chiral system can be monolithic chiral shapes, or chiral aggregates of achiral nanostructures. This work explores a particular category of chiral assemblies, that of dimers formed by achiral nanorods, [1], by means of a theoretical and computational study of the phenomenon. Three interconnected parameters of the dimer were evaluated: interparticle distance, aspect ratio and relative orientation of its silver nanorods. Our data illustrates the known strong dependence of the chiral response on the hybridization of the plasmonic modes through near-field coupling, and explores its dependence with interparticle distance. We show strong CD signals at relatively long interparticle distances than what are typically probed experimentally, pointing to new ways of creating strong chiral scatterers. Increasing the aspect ratio of the rods leads to red-shifted longitudinal plasmonic modes and to stronger hot spots at their tips. Finally, we have analysed the relative relevance of parallel displacements of one rod with respect to another, compared with changes in their relative angle, in order to explore the robustness of their chiral signal to assembly deformations or partial disorder when constructing by iterative surface deposition.

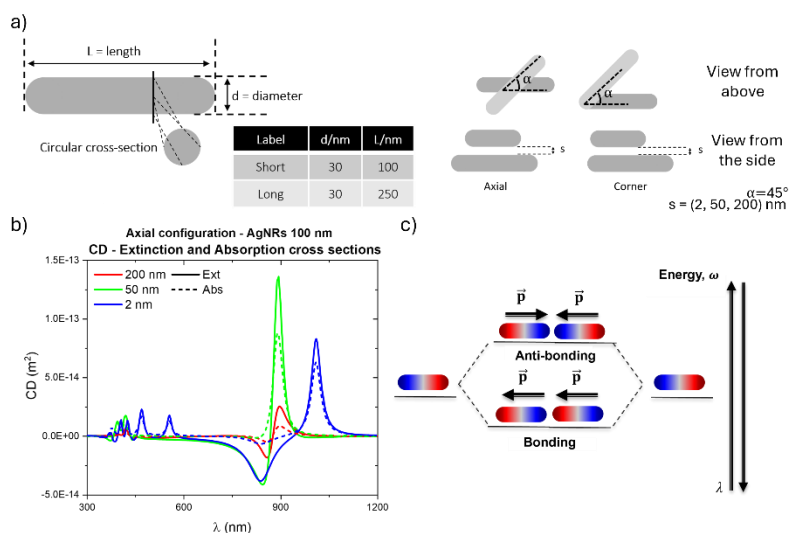


Figure 1. a) Geometrical parameters of a nanorod and the arrangement of the dimer at axial and corner configurations. b) CD spectra of a dimer formed by two 100 nm x 30 nm nanorods sharing the same centre (axial configuration) and separated by different vertical distances: 2 nm, 50 nm and 200 nm c) Diagram of bonding and anti-bonding plasmonic modes.

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Mechanisms underlying visual salience to the SNc/VTa

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Dopamine plays a key role in modulating the basal ganglia, a group of subcortical nuclei involved in procedural learning and action selection, which is well conserved through vertebrate evolution, from lamprey, oldest extant vertebrate, to mammals. Dopaminergic neurons located in the substantia nigra pars compacta (SNc) and ventral tegmental area (VTA) are triggered by salient events. Saliency is the ability of a stimulus to stand out from others as potentially relevant, based on physical features, as speed, size or contrast, to capture our attention. Rapid detection of important events in our surrounding is critical for survival. The SNc/VTA also provides direct dopaminergic projections to brainstem motor centres, including the optic tectum/superior colliculus (OT). In lampreys it has been shown that OT projects to SNc/VTA (Pérez-Fernández et al., 2014), suggesting that the salience responses in the SNc/VTA may be originated in this region, as has been suggested in mammals. However, the mechanisms by which saliency is coded and transmitted to the SNc/VTA are still unknown. For this aim, we used different visual paradigms, applying visual stimulation with screens, using a lamprey eye-brain preparation, to analyse how activity in the SNc/VTA changes in response to individual properties involved in saliency. Using pharmacology and lesioning different brain areas we analysed the neural connectivity and how different areas are involved in salient responses in the SNc/VTA. We demonstrated functionally that the OT is the main visual centre that codifies and sends visual salience to the SNc/VTA. Moreover, we observed that the visual salience in the SNc/VTA is also influenced by the homologue of the parabigeminal nucleus, as in other vertebrates.

Acknowledgements

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Bifunctional APTES-Based Silica Shell Growth on Perovskite Nanocrystals

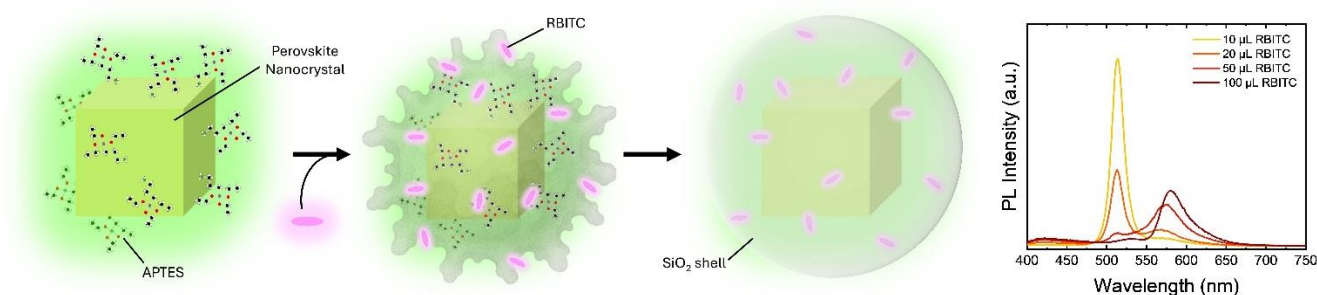
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Despite perovskite nanocrystals have emerged in the last decades in the optoelectronic sector due to their impressive properties,¹ they possess two main drawbacks that harden their implementation into daily devices, i.e., their toxicity and their poor stability against moisture, water and polar organic solvents.² To address these challenges, numerous studies have proposed the development of protective coatings on perovskite surfaces.³ This approach results in core-shell nanocomposites, which prevent the perovskite nanocrystals from external reactive molecules. These molecules have the potential to detach ligands and ions from the surface and outer layers, as well as oxidize lead cations. Such actions can decrease perovskite properties and precipitate the degradation process of the nanoparticles.⁴

Following that route, we propose a two-step synthesis of CsPbBr₃@SiO₂ nanoparticles consisting of the synthesis of CsPbBr₃ nanocubes followed by a ligand exchange of the oleylamine-oleic acid pair by APTES ((3-aminopropyl)triethoxysilane) and its spontaneous silanization along the second step through -Si-O-Si- bonds among APTES molecules. This protocol results in the individual coating of the nanocrystals, as has been proven by HRTEM-EDX, with negligible shift in their optical properties. Furthermore, the use of APTES as silica precursor allows not only the silica growth around the perovskite nanocrystal, but also the functionalization of the composite through the amine terminal group. As an example, we have developed and optimized perovskite functionalization with rhodamine B isothiocyanate (RBITC), which can be linked covalently to APTES and results in a dual-emission particle (Scheme 1).



Scheme 1. RBITC-functionalization of perovskite@silica nanocomposites by RBITC-APTES link along SiO₂ growth and the final photoluminescence spectra for increasing RBITC concentration.

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Targeted delivery of CDK4/6 inhibitors using hybrid magnetic nanoparticles in melanoma spheroids

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Melanoma is considered the most aggressive and lethal type of skin cancer^[1]. Although significant progress has been made in targeted and immunotherapies, their clinical effectiveness is still hampered by intrinsic non-responsiveness and the development of acquired resistance mechanisms^[2,3]. In melanoma, deletion or inactivation of the *CDKN2A* tumour suppressor gene promotes abnormal CDK4/6 activation, leading to uncontrolled cell cycle progression and metastatic dissemination^[4,5]. Consequently, CDK4/6 inhibitors have emerged as promising therapeutic agents, as they suppress tumour cell proliferation and promote G1 phase cell cycle arrest^[6].

To establish a robust platform for therapy screening, a 3D multicellular melanoma spheroid model was developed using the liquid-overlay technique. Spheroids composed of A375 melanoma cells, A375 cells embedded in Matrigel, and A375 cells co-cultured with Human Dermal Fibroblasts (HDF) were generated at different seeding densities. Among the tested conditions, A375-HDF spheroids exhibited the most physiologically relevant phenotype, characterized by a compact architecture, sustained metabolic activity, and the presence of hypoxic and necrotic core regions at higher cell densities. Additionally, CellTracker labelling was performed in A375-HDF spheroids to evaluate the spatial organization of melanoma cells and fibroblasts within the 3D model. This model was subsequently used to evaluate immunomodulatory magnetic lipid nanovehicles (mLNVs) loaded with CDK4/6 inhibitors. The nanoparticles were produced using a one-step modified melt-emulsification method and characterized regarding morphology and crystallinity (TEM, XRD), hydrodynamic size and surface charge (DLS), thermal stability (TGA), magnetic properties (VSM), and MRI relaxivity. Encapsulation efficiency and drug loading of CDK4/6 inhibitors and iron oxide cores were quantified by UV-Vis and ICP-OES, respectively.

Treatment with mLNVs@CDK4/6 inhibitors compromised spheroid structural organization, resulting in decreased spheroid size and compactness, together with enhanced cell death. These findings suggest that mLNV-mediated delivery of CDK4/6 inhibitors effectively impairs melanoma spheroid growth and viability in a physiologically relevant 3D microenvironment.

Overall, the developed model successfully reproduced key characteristics of the TME, providing a reliable platform for therapeutic screening. Furthermore, mLNVs@CDK4/6 inhibitors demonstrated strong potential as a targeted therapeutic strategy for melanoma and other solid tumours.

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Plasmonic supraparticles for SERS detection of water contaminants

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Rapid industrialization has led to the accumulation of toxic pollutants in the environment, creating an urgent need for sensitive and selective detection technologies. Metal–organic frameworks (MOFs), owing to their tuneable porosity, have emerged as promising materials for molecular adsorption and sensing^{1,2}. Surface-enhanced Raman scattering (SERS) spectroscopy enables ultrasensitive detection through signal amplification near plasmonic nanostructures, and its integration with MOFs can further enhance sensitivity through trapping effects and improve selectivity via molecular sieving. In addition, plasmonic supraparticles have recently emerged as highly promising SERS substrates³. Their assembled nanoparticle architecture generates a high density of electromagnetic “hot spots” due to strong interparticle plasmonic coupling. Moreover, their intrinsic porosity and interparticle voids facilitate the preconcentration of analytes, increasing the local analyte density near the enhancing surface and thereby improving detection sensitivity⁴.

Bearing in mind all this explanation, the main objective of this work is to synthesize plasmonic supraparticles using core-shell Au@Ag@ZIF-8 nanoparticles as building blocks and study their SERS capabilities for detection of water pollutants. To this end, a reported protocol³ was followed to synthesize plasmonic core-shell nanoparticles with a shell thickness of ZIF-8 of 110 nm and average size of 340 nm with a plasmon band centered in 800 nm. To fabricate the supraparticles a microemulsion method was followed in which the water droplets containing the nanoparticles evaporated over time and forced them to assemble in the desired structures. The influence of the surfactant in the oil phase is key to preventing the nanoparticles to disperse out of droplet and stabilizing the formation of the supraparticle. Therefore, it was necessary to optimize parameters such as surfactant concentration and type⁵. Finally, SERS efficiency of the supraparticles was tested using methylene blue as a model water contaminant. The results demonstrated that this system presents high sensitivity for detecting pollutants in water.

Acknowledgments

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Exploring HPV ctDNA and immune profiling for disease monitoring in cervical cancer patients

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Cervical cancer remains one of the leading causes of cancer-related mortality among women worldwide. Persistent infection with high-risk Human Papillomavirus (HPV) genotypes is responsible for approximately 95% of cases, particularly HPV16 and HPV18¹⁻². Despite advances in prevention and treatment, 30–60% of patients with advanced disease develop recurrence or progression³, highlighting the need for reliable biomarkers to improve disease monitoring and prognostic stratification.

In this study, we evaluate the potential of liquid biopsy-based detection of circulating HPV DNA combined with immune profiling to characterize cervical cancer progression across different disease stages.

We collected peripheral blood samples from patients with locally advanced and metastatic disease at diagnosis, during treatment, and throughout follow-up at Álvaro Cunqueiro Hospital in Vigo (CEI 2025/103). We isolated circulating free DNA (cfDNA) from plasma using the QIAamp MinElute ccfDNA Mini Kit and analyzed HPV genotypes. In parallel, we isolated peripheral blood mononuclear cells (PBMCs) by Ficoll density gradient centrifugation and analyzed them by flow cytometry to characterize circulating immune populations. When primary tumor tissue was available, we extracted DNA and RNA from formalin-fixed paraffin-embedded (FFPE) samples using the AllPrep DNA/RNA FFPE Kit and evaluated immune infiltration by immunohistochemistry (H&E, CD3+, CD8+, and CD4+).

The integration of molecular and immunological data from blood and primary tumor samples revealed substantial heterogeneity across patients and disease stages, suggesting the presence of distinct profiles potentially associated with treatment response and disease progression.

Overall, this study highlights the potential clinical value of HPV ctDNA detection as a minimally invasive biomarker and warrants further validation in larger cohorts for personalized monitoring and early detection of disease progression in cervical cancer patients.

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Chirality Engineering of Covalent Organic Frameworks for Electrochemical Water Oxidation

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The oxygen evolution reaction (OER) is a critical bottleneck in green hydrogen production by water electrolysis. This is due to its sluggish kinetics and the requirement to form ground-state triplet oxygen, $^3\text{O}_2$, singlet state reactant and intermediates [1]. Recent breakthroughs have highlighted the potential of chiral catalysts to facilitate the formation of $^3\text{O}_2$ via spin filtering through the chirality-induced spin selectivity effect [2]. Although correlations between chiroptical activity and catalytic performance have been suggested, this relationship remains incompletely understood due to the limited number of systematic investigations.

In this work, we systematically modulate the degree of chirality in chiral covalent organic frameworks (COFs) via a chiral induction, enabling precise control over the chiroptical properties of the resulting materials. A series of chiral COFs with tunable optical activity was synthesized and comprehensively characterized to elucidate the relationship between the structure and chiroptical properties, with the dissymmetry factor (g -factor) employed as a quantitative descriptor of the chiroptical response. Circular dichroism spectroscopy (Figure 1), along with chemical and structural analyses are employed to confirm the induced chirality and its systematic variation across the series. The resulting materials were subsequently evaluated as electrocatalysts for OER. Electrochemical measurements reveal a clear correlation between chiroptical activity and catalytic performance: catalysts with higher g -factors exhibit lower overpotentials and enhanced current densities compared to those with lower or no chiroptical activity.

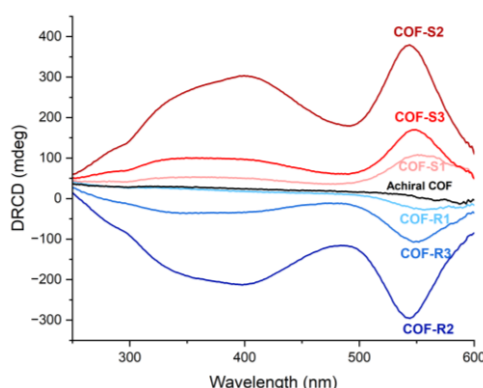


Figure 1. The diffuse reflectance circular dichroism (DRCD) of the prepared COFs.

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A Functional Screening Platform to Test Therapy Response in Sarcoma Patient-Derived Models

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Sarcomas are a heterogeneous group of tumours with limited understanding of disease development and progression, limited therapeutic options, and variable response to treatment. The absence of biomarkers to identify patients who will respond to targeted therapies or immunotherapies limits their clinical use and may expose patients to adverse effects without benefit. Identifying patients who respond to therapy remains a major challenge in the field.

In this project, we established patient-derived models from multiple sarcoma subtypes, including liposarcoma, rhabdomyosarcoma, and osteosarcoma, using optimized protocols for 2D and 3D cultures. Tumour samples were processed for parallel applications, including preservation for omics analysis. Clonogenic assays were used to evaluate the efficacy of targeted therapies currently used in clinical settings, including multikinase inhibitors and DNA damage inhibitors. Drug ranges were defined using control fibroblasts and tumour cell lines to assess toxicity and response. Mechanisms associated with therapy response were analysed by flow cytometry (cell cycle distribution and apoptosis/necrosis) and DNA damage by γ H2AX immunofluorescence. Three-dimensional spheroids were generated using Matrigel to recapitulate tumour architecture. Immune interactions were addressed by co-culture with immune cells, including an NK cell line, establishing conditions for immunotherapy assays, with planned incorporation of patient-derived PBMCs.

Our results support this platform for therapy selection, addressing current limitations in predicting response, and enabling the identification of biomarkers and further analysis of mechanisms involved in treatment response and disease progression.

Magnetoplasmonic Liposomes: A Multi-Technique Journey into Their Structure and Properties

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Multifunctional magnetoplasmonic liposomes (MPLs) are powerful theranostic tools in cancer management, integrating bioimaging, targeted drug delivery, and radiotherapy sensitization. A detailed characterization is key to ensure the therapeutic functionalities required for effective cancer therapy, such as synergistic dual hyperthermia (magneto/photothermia) and controlled drug release. Such a comprehensive understanding is therefore pivotal for the rational design of safe, predictable, and efficient therapeutic performance [1-4].

In this study, core-shell nanostructures featuring a superparamagnetic cubic manganese ferrite core and a gold shell were synthesized and encapsulated into thermosensitive surfactant-lipid bilayers. The structural, photophysical, and magnetic properties of the core-shell nanoparticles were validated by TEM, DLS, XRD, UV-Vis-NIR spectroscopy, and SQUID. Magnetic and photothermal hyperthermia capabilities of the magnetoplasmonic liposomes were evaluated under laser irradiation and AC field, while ICP-OES, NMR, and MRI were used to evaluate their bioimaging potential. Results showed high-purity superparamagnetic cubic cores ($M_s = 82$ emu/g) with oval morphology (~200 nm) after shell growth. Their encapsulation into the surfactant-lipid bilayers was confirmed by FRET, with the resulting nanosystem demonstrating strong heating performance of 30°C under laser irradiation. Furthermore, radiosensitization was demonstrated using gamma radiation (1 Gy/min) in vitro and bioimaging potential was confirmed via MRI phantoms.

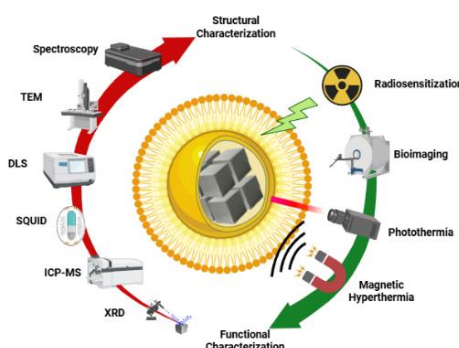


Figure 1: Overview of the characterization techniques and functional facets of the MPLs

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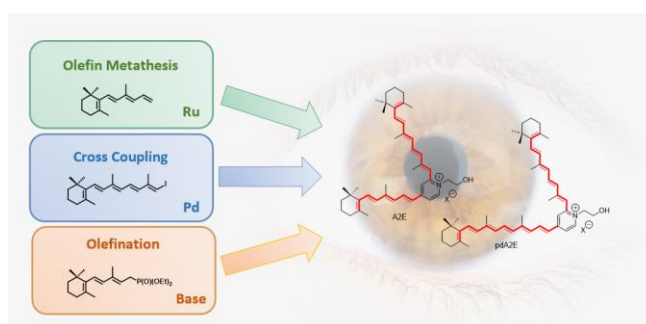
Stereochemical Reassignment by Total Synthesis of an Ocular Pyridinium Bisretinoid of Retinal Pigment Epithelium Lipofuscin: *ii*so-A2E Is *i*-A2E

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Alternative tactics for polyene construction have been explored for the total synthesis of lipofuscin fluorophores A2E and pentadienyl-extended analogue pdA2E starting from properly functionalized pyridines.¹ The bidirectional acyclic cross-metathesis (ACM) reaction of a C2-dienyl, C4-vinylpyridine with excess of a conjugated tetraene unexpectedly afforded a C2-dienyl, C4-tetraenylpyridine with extended conjugation at just one of the branches. Although the stepwise process involving *N*-alkylation and a second ACM of the resulting pyridinium ion with the same tetraene generated A2E, however, the inconsistent results of the last ACM led to complete the skeleton using instead a Horner-Wadsworth-Emmons (HWE) condensation reaction of the C2-pentadienal-functionalized pyridine with a trienylphosphonate. The ACM proceeded even in lower yields in this case, thus showing the limitations of ACM for polyene synthesis. As alternative, the C4-tetraenyl- and the C4-hexaenylpyridine branches present in A2E and pdA2E were constructed by a Suzuki-Miyaura cross-coupling of a pyridine alkenylboronate and a trienyl- or a pentaenyliodide, respectively, while extending the common C2-pentaenyl arms by a HWE reaction. Pyridine alkylation completed the synthesis of the lipofuscin fluorophores and confirmed the stereostructure of pdA2E, namely the double bond geometries and the relative location of the longer unsaturated chain on the pyridinium ring.



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Dynamic Chiral Metallo-Supramolecular Polymers

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A novel methodology for the preparation of a new class of metallo-supramolecular aggregates is reported. These polymers are formed by combining phenylacetylene monomers with a silver salt, leading to *in situ* self-assembly. The morphology can be tuned by adjusting the monomer-to-silver(I) ratio.

In addition, the use of different silver salts allows control over the helical handedness, while the aggregation behavior can be further tuned by increasing the length of the rigid spacer, based on oligophenylene ethynylene (OPE) units. This approach offers a simple and effective way to control both the structure and chirality of these systems [1, 2].

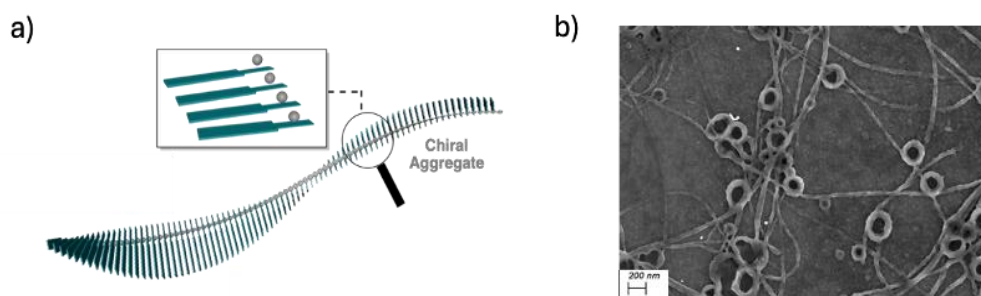


Figure 1. a) Ag-cation aggregation of a phenylacetylene monomer b) SEM image of the aggregate

Acknowledgements

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Senotherapeutic peptides targeting the C-terminal domain of Cx43 facilitate a pro-regenerative environment and provide a targeted therapy to prevent osteoarthritis progression

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Osteoarthritis (OA) is a prevalent age-related disorder characterized by progressive cartilage breakdown, synovial degeneration, chronic pain, and loss of joint function. Cellular senescence has been implicated in OA pathogenesis, but specific mechanistic targets remain poorly defined, limiting therapeutic development. We identified connexin43 (Cx43)-mediated senescence as a central driver of OA progression, independent of classical triggers such as aging or obesity, and present from early disease stages. In this study, we evaluated two peptides targeting the C-terminal domain (CTD) of Cx43 as potential senotherapeutic agents. These peptides reduced Cx43 expression and protein levels, decreased senescent cell burden, and downregulated SASP-associated inflammatory mediators involved in cartilage degradation and disease progression. Functionally, treatment promoted chondrocyte redifferentiation and enhanced extracellular matrix deposition in 3D in vitro models. Importantly, intra-articular administration of the peptides in a murine OA model improved tissue regeneration, supporting their in vivo efficacy. By attenuating senescence and SASP activity, this strategy fosters a regenerative joint environment. Overall, targeting the Cx43 CTD with senotherapeutic peptides represents a promising disease-modifying approach for OA, and may also be relevant for other age-related conditions in which aberrant Cx43-driven senescence contributes to pathology, such as impaired wound healing.

Chitosan-agarose gels containing niosomes for controlled drug release

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Cancer remains a major societal challenge, characterized by a high incidence, heterogeneity, adaptability and resistance to drugs. Despite advancements in the chemotherapy, it remains limited by the low efficacy and lack of target specificity thus commonly requiring high drug concentrations that lead to harmful side effects. Drug delivery systems, such as hydrogels, can be locally applied and enable the controlled release of drugs, thus improving the therapeutic efficacy while averting side effects. However, the addition of stimuli responsive that can affect the gel properties. Besides, the high hydrophilicity of hydrogels commonly results in the burst release, limiting the range of therapeutic agents that can be delivered. The combination of gels with composites, such as niosomes, is anticipated to enable the development of stimuli-responsive hydrogels, while improving the sustained drug release without requiring chemical modifications of the gel and thus also averting the need for toxic chemical crosslinking agents.

In this work, composite chitosan-agarose hydrogels containing niosomes were developed for the controlled and stimuli-responsive release of a hydrophilic model drug, 5(6)-carboxyfluorescein. The gel components enabled the tunability of the mechanical properties within a high range of storage modulus (1.5 KPa) while using a low polymer concentration ($\leq 1\%$ wt), as well as a pH-responsive and prolonged drug release. Hereby, the chitosan-agarose niogels are anticipated as a promising material for localized and controlled drug delivery applications, such as in cancer therapy.

MOF-Templated COF Nanostructures for Biosensing Applications

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Hybrid plasmonic porous nanostructures combining Au nanostars (AuNSs), ZIF-8 metal-organic frameworks (MOFs), and imine-linked covalent organic frameworks (COFs) were successfully fabricated through a MOF-templated strategy. In situ COF growth over AuNS@ZIF-8 produced stable core-shell architectures, while selective sacrificial removal of the ZIF-8 template generated hollow yolk-shell AuNS@COF nanostructures preserving the plasmonic core.

Both systems exhibited efficient surface-enhanced Raman scattering (SERS) activity together with high molecular retention capabilities derived from the porous shell. The ZIF-8 intermediate enabled controlled shell formation, whereas the final COF structures provided enhanced aqueous stability and larger accessible porosity compared to the parent MOF, favoring analyte confinement and diffusion near plasmonic hotspots. Importantly, the Au nanostars maintained excellent colloidal stability and optical performance for sensing biologically relevant analytes.

The obtained hybrid platforms combine plasmonic enhancement, molecular confinement and stability in aqueous media, demonstrating strong potential for SERS sensing in biological conditions.

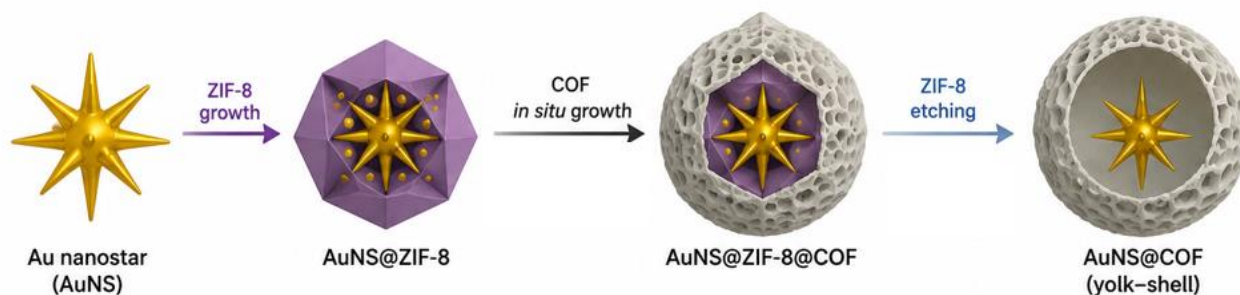


Figure. Schematic synthesis of AuNS@ZIF-8@COF and yolk-shell AuNS@COF nanostructures through MOF-templated COF growth and selective ZIF-8 etching.

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Aerogel Particles for Advanced Pulmonary Drug Delivery Applications

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Aerogels are low-density solid materials characterized by high porosities, open pore structures, and high specific surface areas [1], unique properties achieved through supercritical CO₂ drying, which enables solvent removal while preserving the intrinsic porous nanostructure of the gel network [2]. Aerogels in the form of particles have emerged as promising candidates for next-generation drug delivery systems, offering high drug loading capacity, improved stability for sensitive compounds, and controlled and sustained release profiles. Their engineering currently relies on bottom-up approaches that allow precise control over particle size and shape, such as emulsion-gelation, dripping, spray gelation, and inkjet printing. In the biomedical field, aerogel particles have demonstrated significant potential across multiple administration routes, including oral, skin and pulmonary drug delivery. Namely, the low density and aerodynamic diameters (typically 1–5 µm) are particularly interesting in pulmonary delivery to promote deep lung deposition, enabling both local and systemic delivery of therapeutic agents, with applications ranging from asthma treatment to vaccination and emerging gene therapies [1]. Significant contributions from AerogelsLab have explored these applications and results include the use of inkjet printing to produce alginate microparticles for the pulmonary delivery of salbutamol sulphate [3] and the efficacy of spray-gelated alginate aerogels for the high loading and sustained release of beclomethasone dipropionate (BDP) in dry powder inhalers [4]. In both cases aerogels particles with optimal aerodynamic size for lung deposition were produced and *ex vivo* tests confirmed that BDP released from these aerogels successfully permeates bronchial tissue [3,4]. These advancements bridge the gap between material engineering and therapeutic functionality, reinforcing aerogel particles as promising platforms for future clinical translation and next-generation biomedical applications.

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POSTER SESSION I

Unravelling Antenna Behavior in Porphyrin Hydrogen-Bonded Organic Frameworks: A TD-DFT and FRET Study

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Arrays of light-harvesting molecules with long-range order are promising materials for photons collection and rapidly transfer of solar energy to chemical catalysts. Hydrogen-bonded organic frameworks (HOFs) are particularly attractive as artificial light-harvesting platforms due to their crystalline nature, molecular-scale porosity and comparative ease of synthesis [1]. We present a theoretical investigation of antenna-like light-harvesting behavior in partially metalated porphyrin-based hydrogen-bonded organic frameworks (HOFs) containing both zinc-metalated tetrakis (4-carboxyphenyl) porphyrin (Zn-TCPP; donor) and corresponding free-base porphyrin (FB-TCPP; acceptor) using Förster theory [2] and ab initio calculations. Forster resonance energy transfer (FRET) analysis reveals that energy transfer efficiencies in the HOFs deviate markedly from the solution case due to the fixed orientations of the porphyrin and interlayer transfer rate dominates with respect to the other possible transfer directions in the superstructure. FRET modeling indicates that ~35 ZnTCPP molecules are enough to transfer energy to a centrally sited acceptor (FB-TCPP) molecule [3]. These findings suggest that stacked chromophores within HOFs can act as light harvesting “antennae” and may offer prospective application as photochemical energy conversion systems.

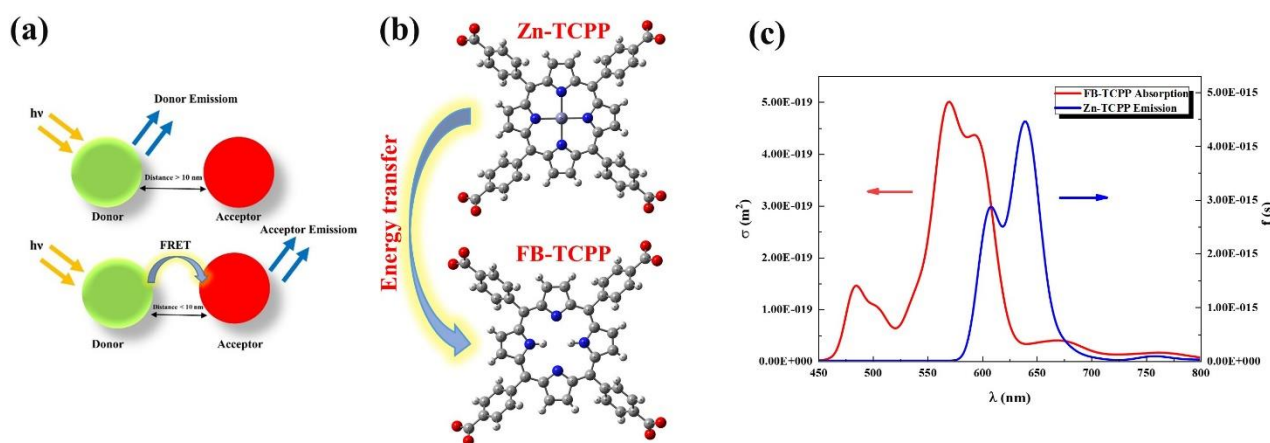


Figure 1: (a) FRET mechanism (b) Ball and stick models of Zn-TCPP (top) and FB-TCPP (bottom) in their optimized configurations (c) Spectral overlap between Absorption spectrum of FB-TCPP and Emission spectrum of Zn-TCPP.

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Short-term effects of micro- and nanoplastics and their mixture with glyphosate on dopaminergic neurotransmission in striatal and cortical homogenates of rat brain

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Introduction: Micro- and nanoplastic pollution is an emerging concern due to its potential neurotoxic effects in mammals. Although previous studies have reported oxidative stress and metabolic alterations, their impact on monoaminergic systems remains poorly understood. In this study, we evaluated the effects of acute exposure to polystyrene micro- and nanoplastics (MNPs-PS), alone or in combination with the organophosphorus pesticide glyphosate, on dopaminergic neurotransmission in corticostriatal pathway. Dopamine, and their main acidic metabolites, DOPAC and HVA, levels were quantified *ex vivo* by HPLC.

Methods: Female Sprague-Dawley adult rats (250-350 g, n=6/group) were used in the experiments. Animals were systemically (via i.p.) exposed to MNPs-PS (0.5 or 1 μ m, 10 mg/kg), alone or in combination with glyphosate (7.5 mg/kg). After 2 h, the striatum and prefrontal cortex (PFC) were dissected, and dopamine, DOPAC, and HVA levels were quantified by HPLC with electrochemical detection. Data were analysed using one-way ANOVA followed by Bonferroni *post hoc* test. Significant differences were as follow: $P < 0.05$, $P < 0.01$ and $P < 0.001$.

Results: Acute exposure to MNPs-PS induced significant alterations in corticostriatal dopaminergic pathway, which were more pronounced under combined exposure with glyphosate. The striatum was the most affected region, showing marked disruptions in dopaminergic system (dopamine, DOPAC, HVA), particularly in combined treatments. In the PFC, effects were more moderate but still evident, mainly affecting dopamine levels, while its metabolites remained largely unchanged. Overall, combined exposures elicited stronger neurochemical disturbances than individual treatments, highlighting a potentiation of dopaminergic alterations.

Conclusions: MNPs-PS, alone or combined with glyphosate, disrupt dopaminergic neurotransmission in a region-dependent manner, with the striatum being especially vulnerable. Combined exposure enhances these effects, suggesting a potentiation of dopaminergic neurotoxicity in key brain regions involved in motor and cognitive functions.

Acknowledgements

The research was supported by the University of Vigo and Xunta de Galicia.

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Structural optimization and post-synthetic modification of a 3D covalent organic framework for gas adsorption

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Covalent organic frameworks (COFs) are crystalline porous materials of high interest for gas adsorption and separation applications due to their high surface area and tunable pore size, shape, and functionalization. However, achieving high-quality COFs with crystallinity and porosity is highly dependent on synthetic conditions and remains non-trivial. Structural modulators, *i.e.*, molecules that compete with framework-forming building blocks during synthesis, have emerged as an effective strategy to regulate nucleation and crystal growth [1], often leading to improved crystallinity and porosity.

In this work, aniline is employed as a structural modulator in the synthesis of 3D-TPB-COF-H [2], a three-dimensional imine-based COF. By competing with the amine building block during imine-bond formation, the use of aniline gave access to material with increased crystallinity and surface area as compared to the conventional synthesis. Post-synthetic modification of the imine linkages was further explored as a complementary strategy, including reduction to amine and oxidation to amide functionalities, to tailor the internal chemical environment of the framework.

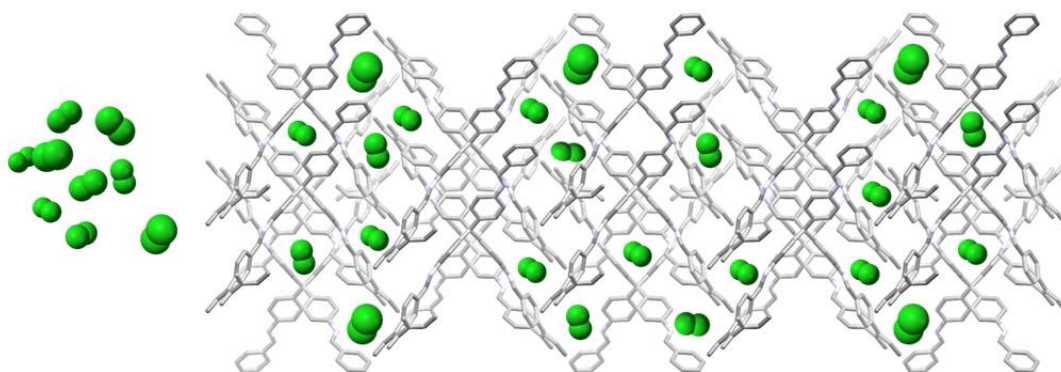


Figure.1 Schematic representation of gas adsorption in 3D-TPB-COF-H.

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Microwave-assisted extraction of the green seaweed *Ulva spp.* in different extraction cycles using eutectic mixtures

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The green macroalgae *Ulva spp.* is a valuable source of sulfated polysaccharides, known as ulvan, with relevant biomedical applications such as drug delivery systems and the fabrication of films and hydrogels [2]. This study evaluated ulvan extraction from *Ulva spp.* using microwave-assisted extraction (MAE) at a solid-to-liquid ratio of 1:30, 160 °C, and 5 min. Three deep eutectic solvent (DES) systems were applied: betaine/1,3-butanediol, choline chloride/1,4-butanediol, and choline chloride/ethylene glycol, at molar ratios of 1:1, 1:5, and 1:2, respectively, combined with 50%, 30%, and 30% (v/v) distilled water/thermal water. Extraction yields of 72%, 64%, and 65% were obtained for the respective solvent systems. Ulvan recovery was quantified via ethanol precipitation (1:1.5 ratio). The DES were characterized by physicochemical properties (pH, viscosity, density, conductivity) and FTIR analysis, revealing a characteristic band at 1025–1068 cm⁻¹ associated with C–O and C–OH typical of sugar-based DES systems [1]. Ulvan recovery was assessed over three extraction cycles, showing a progressive decrease upon solvent reuse. Total phenolic content of extracts obtained with the betaine/1,3-butanediol system was also evaluated after each cycle, decreasing from 0.21 to 0.05 mg gallic acid/g extract under distilled water conditions, and from 0.34 to 0.04 mg gallic acid/g extract under thermal water conditions.

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Metal cation inducing dimensional engineering of Perovskite Nanocrystal towards chiral superstructure

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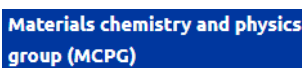
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Perovskite nanocrystals have gained enormous attention in the recent time for impressive optoelectronic and photovoltaic properties. Yet, their chiral analogues have largely remained underdeveloped, despite their potential for precise manipulation of photon spin angular momentum. A few initial reports with different metal-doped perovskite materials show promising circular dichroism (CD) and circularly polarized luminescence (CPL), although research in this area is still in its infancy. In this work, we are introducing an interfacial Zn²⁺ doping strategy using a molecular shuttle to prepare highly luminescent 3D/2D CsPb(Cl/Br)₃@Zn hybrid nanoplate (CPC@Zn), which subsequently self-assemble into a chiral superstructure. The superstructure of CPC@Zn showcases a clear CD and CPL signal with a high order of reproducibility throughout all batches. Moreover, the hybrid CPC@Zn is highly stable with a strong luminance for a longer period of time, indicating its opportunity towards fabricating high contrast stereoscopic imaging solution for 3D display, spin photonic device, and quantum communication devices. Overall, our results establish a robust strategy for synthesizing chiral perovskite nanocrystals without the requirement of traditional ligand exchange or post-synthetic chirality induction, opening new avenues for quantum technologies.

Keywords: Chiral perovskite nanocrystal, CsPb(Cl/Br)₃@Zn, Circular dichroism, Circular polarized luminescent, Chiral superstructure.

Acknowledgements



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Coestimation of recombination and substitution rates from protein sequences integrating structural constraints

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An accurate quantification of mutation and recombination is crucial for the understanding of the strength of the evolutionary process. However, the estimation of these parameters from protein sequences, in contrast to nucleotide sequences, has been little explored, especially for recombination, despite protein sequencing tools are routinely used. We developed a computational framework, named *ProteinEvolverABC2*, that co-estimates substitution and recombination rates from protein sequences by using the approximate Bayesian computation approach, with and without regression adjustments. The framework incorporates a variety of fixed and nuisance population genetics parameters, as well as evolutionary constraints derived from the protein structure, which are used to simulate data and to calculate informative summary statistics for the co-estimation. The validation showed accurate co-estimation of both parameters under different substitution models of protein evolution and proportion of accepted simulations. As expected, its performance was poorer at extreme levels of sequence diversity due to reduced genetic signatures of substitution and recombination events and, there, accounting for structural constraints could slightly improve the estimates. As illustrative examples, we applied the framework to viral protein families of general interest, including the coronavirus RNA synthesis protein NSP10 and 2'-O-methyltransferase.

Acknowledgements

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Planar chirality as chiral source to create dynamic helical polymers

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In this project, a [2,2]-paracyclophane-derived monomer, provided by Dr. Rosa López from the Department of Organic Chemistry in San Sebastián, was studied. This monomer exhibits planar chirality when appropriately substituted on its aromatic rings and, in this case, corresponds to a monosubstituted [2,2]-paracyclophane bearing a 1,4-diethynylbenzyl group¹.

Starting from this building block, a covalent helical polymer was synthesized using a rhodium catalyst, which promotes the formation of cis linkages along the polyene chain and leads to a well-defined helical macromolecular structure. The planar chirality of the monomer is efficiently transferred during polymerization, resulting in a chiral polymer with a stable helical arrangement².

A key feature of this material is its dynamic response to external stimuli, including solvent polarity, the nature of surrounding molecules, and the presence of metal species. This behaviour is particularly notable given the absence of heteroatoms in the polymer backbone, highlighting the importance of non-covalent interactions and supramolecular organization.

Overall, this polymer shows promising potential as a functional material for applications in smart systems, molecular recognition, chiral sensing or molecular encapsulation.

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Ultrasound spray-drying microencapsulation of gram-negative bacteria using composite polysaccharidic matrices

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The preservation and stabilization of Gram-negative bacteria remain major challenges in biomedical and biotechnological applications due to their sensitivity to dehydration, thermal stress, and long-term storage conditions. Developing effective encapsulation strategies is therefore essential to improve bacterial viability during processing, transport, and storage [1]. In this study, we evaluated ultrasound-assisted spray-drying microencapsulation as a platform for enhancing the stability of *Bradyrhizobium diazoefficiens*, a Gram-negative model bacterium, using composite polysaccharide-based matrices. We hypothesized that optimized formulations and spray-drying parameters could improve bacterial protection and post-processing survival. Bacterial cells were encapsulated in matrices containing different ratios of ulvan, trehalose, and maltodextrin and subjected to varying spray-drying conditions. Process optimization was performed based on powder recovery, residual moisture, and immediate bacterial survival following drying. Storage stability was assessed over 14 days under room temperature (25 °C), refrigerated (7 °C), and frozen (-18 °C) conditions. Encapsulation efficiency, particle morphology, and size distribution were further characterized using scanning electron microscopy. In sum, ultrasound spray-drying microencapsulation has a promising potential for the preservation and delivery of sensitive Gram-negative bacteria in biomedical and biotechnological applications.

Acknowledgements

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Shrimp shells to prevent ocular pathologies

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Shrimp processing waste harbours bioactive compounds with remarkable pharmaceutical potential. In this study chitin and a bioactive lipidic fraction were recovered from shrimp exoskeleton. These fractions were reassembled into chitosan-tripolyphosphate (TPP)- based nanoparticles, where chitosan formed the matrix and the encapsulated lipidic fraction provided the antioxidant properties. The nanocarrier showed a hydrodynamic diameter of 326.3 nm, confirmed by SEM (Fig. 1a), a polydispersity index of 0.189, and a ζ -potential of 45.59 mV. The antioxidant activity of the lipid fraction was retained upon encapsulation, as confirmed by ABTS and FRAP assays, with 50% of the radical scavenging capacity and 0.02 mg GAE/mL reducing power (Fig. 1b), showing a more predictable behaviour than the crude extract. The mucoadhesive properties were assessed through mucin-binding assays, revealing the formation of stable complexes well-suited for ophthalmic drug delivery. The cytoprotective capacity of the formulation was then evaluated in ARPE-19 retinal pigment epithelial cells, monitoring mitochondrial reactive oxygen species (ROS) generation (Fig. 1c) and cell viability under chemically induced oxidative stress. Encapsulation markedly reduced the toxicity of the crude extract, and following oxidative stress, metabolic cell activity rose up to 120%, indicating that the nanocarrier not only counteracts oxidative stress but also supports enhanced cellular proliferation.

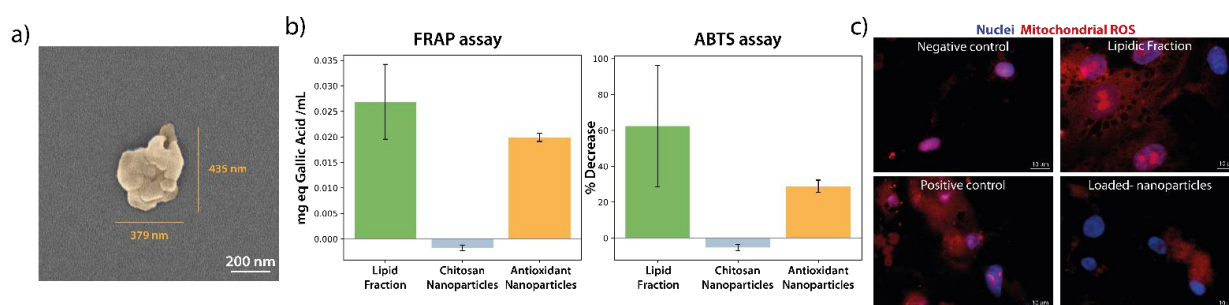


Figure 1. (a) SEM image of the loaded nanoparticles. (b) FRAP and ABTS activity for the lipid fraction, chitosan and loaded nanoparticles. (c) Fluorescence microscopy images showing ROS generation.

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In situ monitoring and protection of cell oxidative stress by SERS

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Oxidative stress in macrophages is closely associated with mitochondrial redox imbalance, yet conventional fluorescence assays usually provide endpoint functional information rather than molecule-resolved, in situ biochemical readouts.¹ Here, we develop PE-Au nanoprobe that integrate epigallocatechin gallate (EGCG), a cysteine-terminated arginine-rich peptide, F127, and Au into a mitochondria-biased plasmonic nanoassembly for simultaneous protection and monitoring of oxidative stress. Multiscale simulations and quantum chemical calculations support a hydrophobically driven pre-assembly process, followed by ligand-centered Au reduction and interfacial metallization to generate rough Au-rich PE-Au nanostructures. In H₂O₂-challenged RAW 264.7 macrophages, the nanoprobe reduce mitochondrial superoxide accumulation and partially preserve membrane polarization, as validated by MitoSOX and JC-1 fluorescence. Coupling the cellular system with an Au nanosphere-coated Si substrate enables in situ surface-enhanced Raman spectroscopy (SERS) to resolve treatment-dependent molecular fingerprints, including redox- and membrane-associated Raman ratios and PCA-separated spectral states. This protect-and-monitor platform links mitochondrial-targeted oxidative-stress attenuation with Raman-resolved molecular reporting, offering a strategy for probing subcellular stress chemistry in living cells.

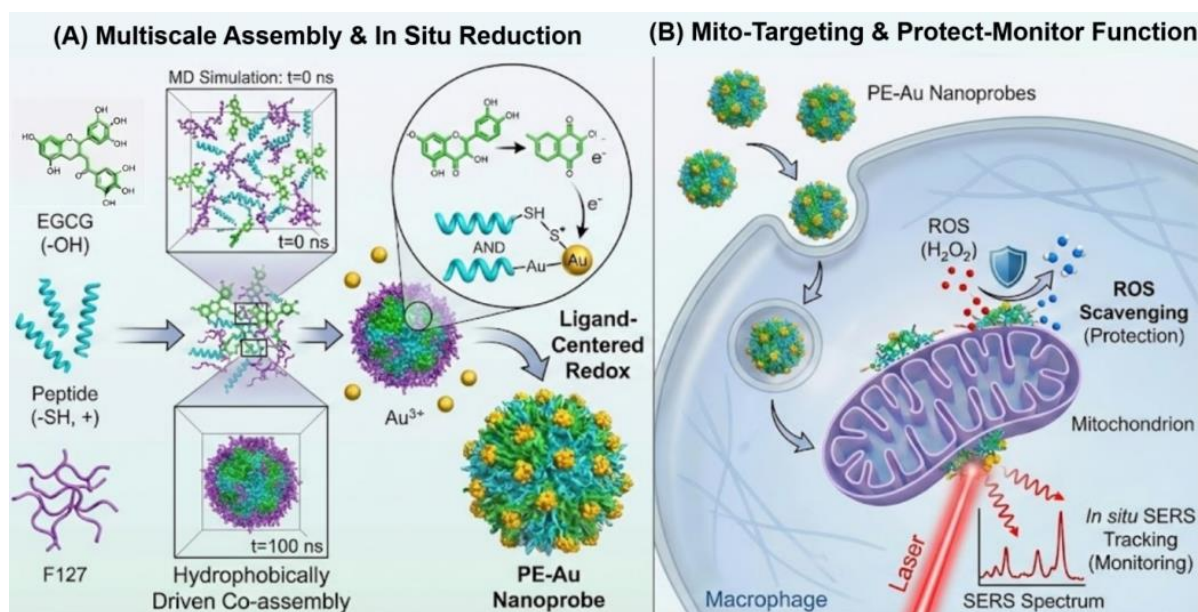


Figure. Multiscale co-assembly, ligand-centered reduction, and mitochondria-targeted protect-and-monitor function of PE-Au nanoprobe.

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Control of Dynamic Chiral Properties in Helical Poly(diphenylacetylene) Derivatives upon Photoirradiation

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Poly(diphenylacetylene) derivatives (PDPAs) are thermally and chemically stable π -conjugated helical polymers. We reported PDPAs form a one-handed helical structure upon thermal annealing in the presence of optically active compounds (helicity induction), and the induced helicity can be stably maintained at room temperature even after the removal of the optically active compounds (helicity memory). Due to their high helicity inversion barrier, heating at high temperatures is required to erase (racemize) the helicity memory of PDPAs. In this work, we investigated the stability of the helicity memory of *h*-poly-1 bearing achiral ester group in the side chain under photoirradiation. The helical structural changes upon photoirradiation of the right-handed *P*-poly-2R bearing optically active ester group^[1] were also investigated.

Poly-1 formed a one-handed helical structure after heating in (*S*)-limonene ((*S*)-a) at 70 °C, and *h*-poly-1 with helicity memory was isolated by removing (*S*)-a (Figure 1A). Circular dichroism (CD) measurement of *h*-poly-1 showed almost no change in the induced CD (ICD) in the polyene backbone absorption region even after standing at 20 °C for 24 h in the dark, indicating that its helicity memory was stably maintained. On the other hand, under blue light (450 nm) irradiation, the ICD intensity became almost zero at 20 °C, suggesting that the helicity memory was rapidly lost by photo-racemization. The resulting racemized poly-1 formed one-handed helical structure again by heating in (*S*)-a. The right-handed helical structure of *P*-poly-2R was also stable in toluene at 20 °C in the dark (Figure 1B). Interestingly, under blue light irradiation at 20 °C, the helix-sense of *P*-poly-2R was inverted to afford the left-handed helical *M*-poly-2R. These results demonstrated that the dynamic properties and helix-sense in PDPAs can be controlled by photoirradiation without heating.

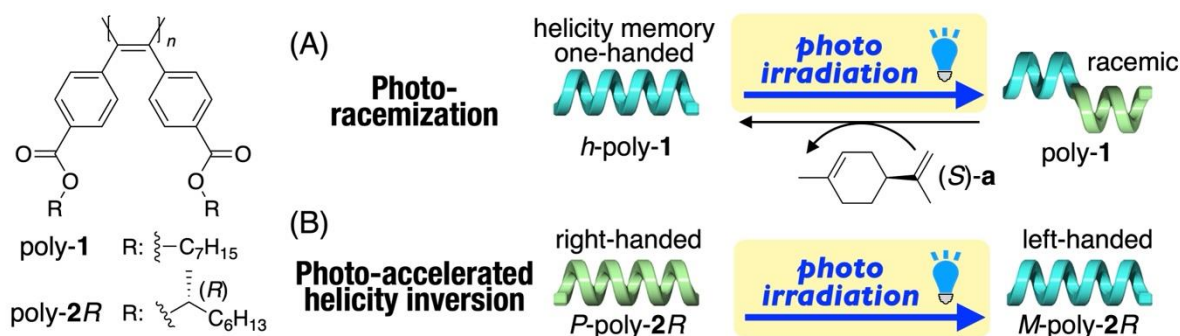


Figure 1. Schematic illustration of (A) photo-racemization in helicity memorized *h*-poly-1 induced by (*S*)-limonene ((*S*)-a) and (B) helicity inversion in right-handed *P*-poly-2R accelerated by photoirradiation.

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Absorption and scattering in chiral gold nanoparticles

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Chiral gold nanoparticles (cGNPs) plasmonic modes interact differently with right- and left-circularly polarized light (R- and L-CPL). This difference in the extinction spectra (absorption and scattering) depending on the handedness of the excitation (i.e. circular dichroism), opens new opportunities to explore different applications such as selective heating using CPL, enantioselective detection of different molecules, etc. Additionally, it has been hypothesized that NP's chirality may influence cellular uptake in a chirality-dependent manner, offering potential advantages for biomedical applications [1].

In this work, we synthesized three different c-GNPs: twisted (T-cGNRs), wrinkled (W-cGNRs), and chiral gold helicoids (cGHs) and evaluate the absorption and scattering components of each nanoparticle type. We further assess their photothermal performance, revealing a correlation between absorption % and thermal efficiencies %(iHCE). Our results identify the most efficient chiral nanoparticle candidates for future applications based in absorption or scattering of the light.

Acknowledgements

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Early Detection of Bardet-Biedl Syndrome in South America: A Knowledge-Transfer Kit for Primary Care

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Bardet-Biedl Syndrome (BBS) is an autosomal recessive ciliopathy characterised by retinal dystrophy, early-onset central obesity, postaxial polydactyly, renal dysfunction, variable cognitive disability, and hypogonadism [1]. In South America, limited economic and geographic access to genomic sequencing results in a mean diagnostic delay of approximately 10 years, during which target-organ complications progress without preventive intervention [2].

A knowledge-transfer kit was developed comprising three tools: (1) educational material for primary care physicians covering BBS genetics, clinical criteria, and organ-specific assessment; (2) the BBS-Score, an original 14-item structured clinical scoring tool with a three-tier referral traffic-light system (maximum 13.0 points; priority referral threshold ≥ 5 points); and (3) a multiplexed ARMS-PCR protocol for the simultaneous detection of three high-prevalence mutations — BBS1 p.Met390Arg (c.1169T>G), BBS10 p.Cys91fsX95 (c.271_272insC), and BBS2 p.Arg275Ter (c.823C>T) — in a single reaction using conventional reagents suitable for low-complexity laboratories [3].

The multiplexed ARMS-PCR assay achieves an estimated diagnostic coverage of 42.5% of BBS cases in the South American population (BBS1: 31.6%; BBS10: 8.07%; BBS2: 2.86%), making it the highest-yield first-tier molecular tool available in resource-limited settings.

This low-cost, adaptable kit addresses the diagnostic gap in South America by combining clinical suspicion tools with accessible molecular screening, without requiring whole-exome sequencing infrastructure. Its implementation at the primary care level has the potential to significantly reduce BBS diagnostic delay and its irreversible organ-damage consequences, while generating local evidence on phenotypic presentation and genotypic distribution of BBS in the region.

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Characterisation of epigenetic regulation on the immunogenicity of ccRCC

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In recent years, immunotherapy has become one of the main therapeutic strategies for clear cell renal carcinoma (ccRCC), although its effectiveness is still limited due to the ability of tumour cells to evade the immune system [1]. Tumour progression and immunogenicity are closely linked to epigenetic reprogramming, which is involved in the regulation of cellular processes such as the epithelial-mesenchymal transition (EMT) [2], the expression of transposable elements [3] and the activity of Polycomb complex [4].

The aim of this study was to determine the effect of the epigenetic treatments azacitidine (a DNA methyltransferase inhibitor) and panobinostat (a histone deacetylase inhibitor) [5] on gene expression and epigenetic regulation. As an *in vitro* model, we used the 786-O and CAKI-1 cell lines, derived from primary and metastatic ccRCC respectively. We used Western Blot to quantify DNMT1, acH3, EZH2 and HDAC1, which are regulatory proteins that modulate epigenetic processes. Moreover, we used real time polymerase chain reaction (qPCR) to assess changes in the expression of the genes *VIM*, *ZEB1*, *ZEB2*, *SNAIL*, *EPCAM* and *CDH1* related with ETM; *BIM* and *EZH2*, related with Polycomb complex; and the transposable elements *LINE-1* and *HERV-NM*.

Our results confirmed that the treatments with azacitidine and panobinostat induces an epigenetic reprogramming in both cell lines, as reflected in changes in the abundance of the epigenetic regulators DNMT1, acH3 and HDAC1, while EZH2 protein levels does not change. In addition, we detected changes in gene expression and in the expression of transposable elements.

In conclusion, azacitidine and panobinostat induce important changes in the expression of key processes such as EMT, Polycomb Complex and transposable elements, supporting further investigation into the potential that these epigenetic therapies may offer for the treatment of this type of cancer.

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Recovery of Bioactive Compounds and Biopolymers from *Limnospira platensis* for Cosmetic and Nutraceutical Applications

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Microalgae represent a renewable resource with significant potential for the development of sustainable biorefineries. However, further optimization of downstream processing is required to fully exploit their value. In this context, this study focuses on the efficient recovery of high-value bioactive compounds and biopolymers from cyanobacterial biomass, including *Limnospira platensis*, targeting their application in cosmetic and nutraceutical formulations.

Green extraction approaches were applied to selectively recover key fractions. Lipophilic compounds, such as polyunsaturated fatty acids, were extracted using supercritical CO₂ (Thar Designs SFE-1000F-2-C10 system, Pittsburgh, USA). The addition of ethanol (up to 10% w/w) as a co-solvent enabled the recovery of more polar bioactives, including pigments and phenolic compounds with antioxidant activity. Furthermore, hydrophilic fractions rich in oligosaccharides were obtained from carbohydrate components via subcritical water extraction (Parr reactor series 4848, Parr Instruments, Moline, IL, USA). Extraction conditions were optimized to enhance both yield and functional properties of the recovered fractions. This work prioritizes maximizing the recovery and functionality of bioactive compounds, particularly their antioxidant and emulsifying properties, through environmentally friendly solvents and energy-efficient processes. It supports the development of an integrated and sustainable biorefinery strategy for producing high-value ingredients for cosmetic and nutraceutical applications.

Acknowledgements

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Molecular evolution of the Crimean–Congo hemorrhagic fever virus

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Crimean–Congo hemorrhagic fever virus (CCHFV) is an emerging tick-borne virus with a broad geographic distribution, high genetic diversity and no globally licensed vaccine or specific antiviral treatment, making its evolutionary dynamics a key issue for surveillance and therapy design. This virus has a tripartite RNA genome, composed of the S, M and L segments, that creates opportunities for segment reassortment, while each coding region is exposed to constraints from different host-associated pressures. We analyzed complete CCHFV genome sequences to explore how nucleotide diversity, evolutionary rates, reassortment and molecular adaptation vary across genome segments, coding regions and main known hosts. Our results showed heterogeneous evolutionary patterns. Overall, the detected exchange patterns were more consistent with segment reassortment than with widespread homologous intrasegment recombination. This interpretation was further supported by complete strains showing discordant segment placement across phylogenetic networks, including cases consistent with reassortment involving the M segment or suggesting reassortment affecting the S segment. The M segment also showed the highest nucleotide diversity, whereas the S and L segments remained substantially more conserved. Tick-derived data generally showed higher nucleotide diversity than mammal-derived data across coding regions, suggesting that selection from hosts can contribute to shaping CCHFV genetic variation. Molecular-clock analyses rejected a strict clock, and relaxed-clock methods generated substitution rates on the order of 10^{-4} substitutions per site per year, with variation among segments. Finally, although purifying selection predominated across all coding regions, some positively selected sites were detected in the M segment, indicating localized adaptive flexibility in the glycoprotein-coding region. Taken together, these findings indicate that CCHFV evolution is markedly heterogeneous across the genome, with the M segment acting as the principal focus of reassortment, elevated diversity and adaptive flexibility, while the S and L segments remain comparatively more constrained probably due to preserve essential activity. These findings are critical for understanding CCHFV molecular epidemiology, phylogeographic structure and genomic surveillance, and can provide evolutionary knowledge to inform therapeutical design.

Influence of magnetite coating morphology on the transport dynamics of magnetic nanostructures

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The performance of magnetically driven microsystems is significantly influenced by the structural architecture of their components. This study analyses how switching from 10 nm spherical magnetite nanoparticles synthesised using the Massart method, to larger polyhedral ones alters the transport dynamics of functionalised polystyrene spheres (500 and 1000 nm). By modifying the morphology of the coating, the resulting changes in the magnetic response and the behaviour of the attained nanobeads under external magnetic field gradients are evaluated ^[1].

Following a comprehensive structural and magnetic characterisation (DLS, SEM/TEM, Raman, and XRD), the dynamics of the system are analysed using a magnetic field generator combined with optical microscopy. The transport study is based on a comparative analysis of the mean square displacement (MSD), incorporating metrics from ensemble averaged (EAMSD), time averaged (TAMSD) and both ensemble and time averaged mean-squared-displacement plots (EA-TAMSD), to discern from the diffusive component from the magnetophoretic response ^[2].

Detecting discrepancies between the TAMSD and EAMSD metrics is essential for identifying anomalous diffusion phenomena and breaches of weak ergodicity in the system. Understanding how the geometry of the nanoparticle dictates these differences is a critical step towards ensuring predictable magnetic manipulation.

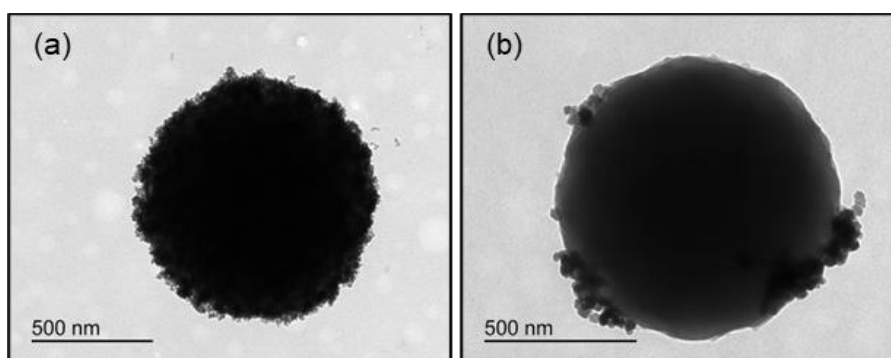


Figure. Polystyrene sphere (1000 nm) coated with; a) Massart's magnetite and b) polyhedral magnetite nanoparticles.

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Reversible halochromic capacity of anthocyanins immobilized within alginate fibres

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Anthocyanins, a pH-responsive pigment (Fig. 1a), are present in natural food like strawberries, blackberries or red cabbage [1]. In this work, we have explored the immobilization of these molecules into an alginate matrix to engineer fibers with halochromic properties. First, anthocyanins were extracted out of red cabbage with a yield of $576,8 \pm 5,9$ mg/kg. This anthocyanin-rich solution was concentrated into a solid extract and mixed with an aqueous alginate dissolution to create the spinning solution that was extruded via wet spinning into a CaCl_2 coagulation bath. Gelation occurs as calcium ions crosslink within the alginate chains forming a polymer network with entrapped anthocyanins (Fig. 1b) [2]. The collected fibers exhibited a fibrous and granular morphology (Fig. 1c), with an elongation at break of $20,85 \pm 4,60$ and a tensile strength of $981,77 \pm 162,62$. The fibre colour response across the pH range 1-14 was evaluated using CIELAB parameters, demonstrating a reversible pH-response upon the successive immersion in buffer solutions (Fig. 1d).

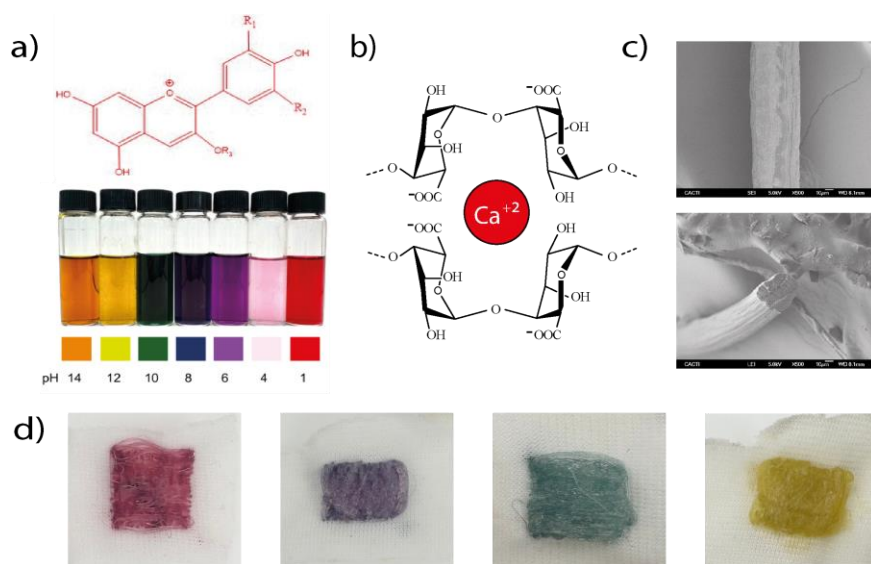


Figure 1: (a) General structure of anthocyanins and colour response based on pH variation. (b) Cross-linking between alginate GG blocks and calcium ions. (c) SEM images of surface and cross section of the collected fibres. (d) pH-response of knitted fibres at pH 1, 6, 9 and 14.

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Nucleus Accumbens astrocyte modulation of feeding

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Classically, astrocytes were considered mere support cells of the central nervous system. However, we now know they actively modulate synaptic transmission through the release of gliotransmitters. The nucleus accumbens (NAc) is a key structure in the reward system that integrates emotional and sensory information to promote goal-directed behaviors, such as food seeking. Neuronal activity in the NAc, specifically within its medial region, has been shown to directly regulate food intake via projections to the lateral hypothalamus (LH), a key region for feeding motivation. In this context, evidence shows that NAc astrocytes express dopamine D1 receptors (D1R) and respond to dopaminergic signals by modulating local synapses. While astrocytes in regions like the hypothalamus are already known to regulate energy balance, their specific involvement in controlling food intake within the NAc reward circuit remains currently unknown. The aim of this study is to determine whether the activity of NAc astrocytes directly regulates food intake, using gain and loss of function models. To achieve this, we quantified food intake in mice where astrocyte activity was either increased or abolished. For that, we used adeno-associated viral vectors to express different tools to modulate NAc astrocyte activity. For astrocyte activation we expressed Gq-DREADDs (Designer Receptors Exclusively Activated by Designer Drugs), a chemogenetic tool that allows to specifically activate astrocytes. Additionally, we inhibited vesicular release from NAc astrocytes by expressing the light chain of the tetanus toxin. These experiments aim to understand whether astrocytic activation or inhibition is sufficient to modify food intake in mice. Ultimately, this model will allow us to elucidate how glia actively modulate the circuits that control feeding behavior.

***Ulva stenophylloides* (Ulvophyceae, Chlorophyta) as a source of hemagglutinating proteins with biotechnological potential: utilization of biomass from green tides**

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Green tides have become a global problem involving several species, especially *Ulva spp.* In Chile, specifically, Algarrobo Bay, they are dominated by *Ulva stenophylloides*, which has only been recorded in Chile, Africa, Australia and New Zealand. Stranded algae cause negative ecological, environmental, economic, and tourism impacts. However, the biomass can be used to obtain molecules with broad functional properties and provide economic benefits to local communities and industry. The objective of this research was to harness the biotechnological potential of algal biomass from Algarrobo Bay. Hemagglutinating protein was partially purified and lyophilized from *U. stenophylloides* biomass using two extraction treatments (cold steeping infusion “A” and liquid nitrogen “B”) for winter and summer. The samples were characterized by SDS-PAGE, a molecular weight of approximately 19 kDa was obtained for all samples. Hemagglutination inhibition (HI) assays showed carbohydrate and blood type-dependent specificity. For winter treatments “A” and “B”, galactose and sucrose showed strong inhibition, especially in blood type A, with HI values around 0.85–0.90 at intermediate dilutions. Sucrose was the most stable inhibitor in blood type B, maintaining HI values close to 1.00 at various dilutions, while D-arabinose was particularly relevant in blood type O, reaching HI values close to 0.90. In contrast, blood type AB showed a more pronounced decrease in inhibition for all sugars. These results suggest that the hemagglutinating molecule recognizes specific glycan patterns, supporting its potential biotechnological use in glycobiology, experimental diagnostics, and functional algal bioproducts. Furthermore, the recovery of residual biomass after extraction showed that carotenoids and chlorophyll b are more sensitive to seasonality, increasing in winter and decreasing in summer. In contrast, total chlorophyll and chlorophyll-a remain stable between seasons. Therefore, the valorization of a resource considered waste serves as a starting point for future research and a blue economy based on a sustainable biorefinery developed from *U. stenophylloides* biomass as a source of additives/components for cosmetic, pharmaceutical, and food products.

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Development and Characterization of a 3D Bacteria-Associated Tumor Spheroid Model

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Three-dimensional (3D) tumor spheroid models have emerged as valuable tools for reproducing key features of the tumor microenvironment (TME), including cell–cell interactions, nutrient gradients and microbial colonization patterns [1]. In parallel, tumor-associated bacteria have gained increasing attention due to their potential influence on tumor progression, immune modulation and therapeutic response [2]. Herein, a fluorescent bacteria-infected 3D tumor spheroid model was developed and characterized as an in vitro platform for studying bacteria–tumor interactions and antimicrobial responses. Tumor spheroids were generated using a liquid-overlay technique under different culture conditions. Spheroid growth and metabolic activity were monitored over time through diameter measurements and AquaBluer assays, allowing the selection of the most stable and compact spheroid condition for subsequent bacterial infection experiments. Following spheroid maturation, GFP-expressing bacteria were introduced into the model. Bacterial colonization and persistence within the spheroids were assessed over time through fluorescence intensity quantification and colony-forming unit (CFU) assays. The spheroids maintained structural integrity throughout the infection period and supported bacterial colonization within the three-dimensional structure. Fluorescence intensity and CFU assays demonstrated successful bacterial colonization and persistence within the spheroid structure over time. The spheroids maintained structural integrity throughout the infection period and exhibited controlled infection dynamics, with higher gentamicin exposure associated with reduced bacterial persistence. Overall, this model represents a promising platform for future investigations involving tumor-associated bacteria, antimicrobial screening and bacteria-mediated therapeutic strategies.

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Characterization of reciprocal connectivity between the nucleus accumbens and the hypothalamus

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Sensory and emotional integration in the nucleus accumbens is an essential subprocess of the brain reward system, eventually resulting in motivational actions driven by extrapyramidal motor outputs. Food intake is one of these actions, and while evidence portrays a strong influence by neuronal activity in this region of the brain, it is the hypothalamus that plays a key role in the feeling of hunger, satiety and the motivational aspects of feeding. Thus, an integrative assessment of the interaction between these two regions is crucial for understanding motivational behavior altogether. The core and shell of the nucleus accumbens are two functionally differentiated regions involved in reward-cue association development and reward prediction/affective processing, respectively. While both predominantly contain GABAergic medium spiny neurons, two separate neuronal pathways can be established: a direct pathway which projects back to the ventral tegmental area and an indirect pathway projecting mainly to the ventral pallidum. In both cases, previous evidence also suggests the presence of back-and-forth, hypothalamus-linked projections; nonetheless, the neuronal types conforming said interconnections remain to be studied in detail. This project aims to histologically and physiologically characterize these connections, thus providing a deeper understanding of the physiology of motivation and allowing further study of possible astroglial-dependant regulation within the pathways.

Computational Analysis of HIV-1 Capsid Resistance to Lenacapavir

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The high mutation rate of HIV-1 promotes the rapid emergence of drug resistant variants, severely challenging the long-term efficacy of antiretroviral therapies. Understanding the precise molecular mechanisms by which these variants affect drug binding while maintaining viral function is essential for predicting evolutionary outcomes and designing inhibitors capable of overcoming resistance. Lenacapavir, a novel capsid inhibitor, exhibits potent activity by binding to the NTD-CTD dimeric interface; however, several treatment-induced mutations that reduce viral susceptibility to the drug have been observed clinically. In this study, we investigate how key hydrophobic and electrostatic mutations affect the binding affinity and structural stability of the Lenacapavir-capsid complex. Using homology models generated with Modeller^{1,2} from PDB 6V2F and the consensus sequence extracted from the HIV Drug Resistance Database³, we established a comparative framework that integrates docking assays and molecular dynamics simulations. We aim to understand how each mutation alters the physical space of the pocket, its flexibility, and the bonds with Lenacapavir. With this dynamic approach, we will be able to better comprehend how HIV-1 develops resistance, which could allow the design of drugs that are more difficult to evade.

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Microcalorimetric study of the growth of *Pediococcus pentosaceus* in an enriched culture medium

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Pediococcus pentosaceus is a Gram-positive lactic acid bacterium used in food fermentation. Bacterial cultures produce energy as a result of bacterial metabolism. The rate of heat production is a suitable measure of the metabolic activity of organisms and their components. Although the heat produced by bacteria is very small, their exponential reproduction in a culture medium allows for heat detection using microcalorimetry. In this study, we analysed the microcalorimetric behaviour of *Pediococcus pentosaceus* using a Calvet microcalorimeter [1], a technique described in previous works [2,3]. The strains of bacteria that have been used were isolated from wheat Tocayo *spp.* cultivated under ecological conditions in Cuenca (Spain) and further characterized in terms of probiotic activity, antibiotic resistance, enzymatic activity, EPS production, antioxidant capacity and aggregation to IEB. As culture medium we have used Soya Casein broth digested with CO₂, which is the most widely used culture medium in hospital clinical practice. The calorimeter contains two stainless steel cells (experimental and reference). The Calvet microcalorimeter is connected to a data acquisition system via a remote interface [4]. Measurements are taken with a microvoltmeter connected to an ESP32 microcontroller, which transmits the data to a remote server using the MQTT protocol. The experiments were conducted with final concentrations of 10⁷ CFU/mL and a constant temperature of 298.15 and 310.15 K was maintained inside the microcalorimeter. By recording the difference in heat potential over time, growth curves of *Pediococcus pentosaceus* were obtained.

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Sustainable Bioactive Compounds Derived from Microalgae and Cyanobacteria for Cosmeceutical and Nutraceutical Applications (SMACC+)

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Sustainable Bioactive Compounds Derived from Microalgae and Cyanobacteria for Cosmeceutical and Nutraceutical Applications (SMACC+) (<https://smacc+.eu>) is a European cooperation project focused on the development of sustainable, high-value bioactive compounds derived from microalgae and cyanobacteria for cosmeceutical and nutraceutical applications. The project promotes eco-efficient biotechnological processes, circular economy approaches, and the replacement of synthetic additives with natural, safe, and effective alternatives.

Co-funded by the European Regional Development Fund (ERDF) under the Interreg Atlantic Area Programme and coordinated by the University of Vigo, the project has a total budget of EUR 2.8 million, of which EUR 2.1 million is provided by the ERDF. The project brings together nine partners from the Atlantic Area, including universities, research organisations, and innovative companies, combining scientific excellence with industrial expertise. The project partners are as follows: CINBIO – Univ. Vigo, La Rochelle Université, University College Dublin, Instituto Tecnológico de Canarias, Instituto Politécnico de Bragança, University of Galway, Alga Biologics, Finnova Foundation, and A4F – Algae for Future.

The objectives of the project are:

- Promote the adoption of sustainable biotechnology-based solutions using microalgae.
- Transfer research knowledge to industry and society.
- Foster collaboration among researchers, companies, students, and policymakers.
- Raise public awareness of the benefits of blue biotechnology.

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Thermally Controlled Chiral Supramolecular Polymorphism in Water

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Biological assemblies like proteins adjust their helical morphology and function based on external stimuli, but achieving similar control in synthetic chiral supramolecular analogues remains a challenge. This study demonstrates a strategy for controlled chiral polymorphism in water using an unsymmetrical oligo(phenyleneethynylene) derivative **1**. By coupling molecular design with thermal stimuli, three distinct assembled states can be achieved: cylinders (**AggI**) at room temperature, transient double helical fibers (**AggII**) near the LCST (≈ 325 K) and irregular planar aggregates (**AggIII**) above the LCST. These transitions are driven by the temperature-dependent conformation and degree of dehydration of the glycol chains. Remarkably, the transient helical phase (**AggII**) can be stabilized and isolated at room temperature through chemical additives like metal salts or co-solvents that directly impact on the LCST. These findings establish LCST-coupled chirality as a versatile platform for developing responsive adaptive materials.

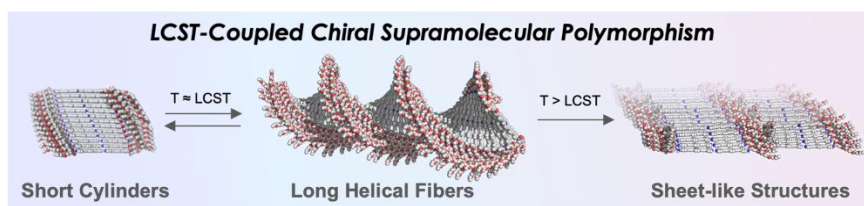


Figure. LCST-coupled chirality as a strategy to regulate thermoresponsive supramolecular polymorphism in water

Acknowledgements

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Addressing Pulmonary Barriers with Hyaluronic Acid Nanoparticles

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The development of efficient delivery systems for poorly soluble drugs remains a major challenge in pharmaceutical sciences, particularly in the context of pulmonary administration, where particle stability, interaction with biological barriers, and preservation of drug activity are critical. In this contribution, hyaluronic acid-based nanoparticles were developed as carriers for poorly soluble corticosteroids and characterized through a combination of physicochemical, structural and biophysical techniques, with a specific focus on their nanoscale organization and behavior in biologically relevant environments.

Nanoparticles were produced as stable dry formulations and reconstituted in aqueous media to obtain nanosuspensions suitable for inhalation. Their structural features were investigated using microscopy, dynamic light scattering and small-angle X-ray scattering (SAXS), enabling insight into particle organization, internal structure and stability under different dispersion conditions. SAXS provided direct information on the nanoscale arrangement of the systems, confirming the formation of well-defined nanostructures and their structural robustness upon dilution and interaction with biomimetic environments. To evaluate their suitability for pulmonary delivery, the interaction of the nanoparticles with model biological barriers was investigated, including mucus-mimicking systems and lung surfactant models.

The results demonstrate that a careful control of nanoscale structure enables the development of biocompatible carriers capable of interacting effectively with respiratory barrier models, providing a promising platform for the inhalation delivery of poorly soluble drugs.

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***In situ* formation of core-shell NPs Fe₃O₄@HgS for Hg enrichment in environmental water samples and quantification by a direct mercury analyzer**

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Mercury (Hg) is one of the most toxic and dangerous elements. The European Commission established the maximum allowed level of Hg in drinking waters as 1 µg/L [1]. Therefore, it is of great importance to develop new analytical methods that involves a preconcentration step in order to increase the sensitivity of available analytical techniques. At that moment, naked or bare magnetite NPs [2], magnetite NPs coated or modified with other chemicals [3-5] have also been used for Hg enrichment by magnetic solid-phase extraction (MSPE) and its miniaturized strategy, dispersive magnetic micro-solid phase extraction (DM-µ-SPE). A novel method with a high greenness profile was developed for the preconcentration and detection of Hg at ultratrace levels in environmental water samples involving magnetic nanoparticles [6]. In this work, the precursor of the nanocomposite formation Fe₃O₄@HgS was the sulphide anion generated upon the ultrasonic decomposition of L-cysteine. This fact results in the efficient trapping of Hg(II) from aqueous samples onto magnetite. Ultrasonic energy can be considered as green energy and L-cysteine is more environmentally friendly reagent than other sulphide precursors such as sodium sulphide. The magnetic sorbent allowed an easy phase separation using a magnet, thus avoiding additional steps of centrifugation or filtration. Finally, a direct mercury analyzer was used for the quantification of the Hg collected onto the magnetic phase. A preconcentration factor of up to 91 and a limit of detection of 0.04 µg/L were reached for Hg (20 mL sample volume). Quantitative Hg recoveries were obtained for aqueous reference materials (96-100 %) and fortified environmental waters, including mineral water, tap water, seawater, fountain water and river water (91-110 %).

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Single-Particle Stokes Analysis of Isotropic and Anisotropic Chiral Gold Nanoparticles

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Chiral nanoparticles uniquely interact with left-handed and right-handed circularly polarized light, generating chiral near-fields that strongly enhance the particle's interaction with surface-bound molecules. Chiral nanoparticles are often composed of complex geometries and fine structural features, where both inter- and intraparticle heterogeneity is commonly observed. This structural heterogeneity strongly impacts the measured optical properties and performance of plasmonic nanoparticles in application, where ensemble averaging in traditional UV-vis and circular dichroism (CD) spectroscopy constrains our ability to perform robust structure-function characterization. Correlated single-particle techniques allow us to overcome such deficiencies, where within a wavelength-resolved Stokes analysis of nanoparticle scattering is used to provide a complete description of optical chirality and optical anisotropy found at the single-particle level. Analysis of both isotropic and anisotropic (a)chiral gold nanoparticles with multiple scattering peaks in the wavelength range of 400 – 1000 nm is presented, where correlation of circular differential scattering (CDS) spectra with ellipticity and polarization azimuth measurements allows for a better understanding of the origins of optical activity in chiral plasmonic nanoparticles. When imaged on a finder transmission electron microscopy (TEM) grid, specific optical signatures can be associated with unique structural features through correlated electron microscopy analysis, leading to more targeted design, greater near-field enhancement, and more efficient use of chiral nanoparticles in application.

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Optimization of plasmid DNA cloning for the study of the INTU gene

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The CPLANE (Ciliogenesis and Planar Polarity Effector) complex is essential for planar cell polarity and the ciliogenesis of the primary cilium. As critical sensory organelles, primary cilia govern key pathways like Sonic Hedgehog (Shh) to maintain tissue homeostasis, therefore, their dysfunction leads to defective organogenesis. A core component of the CPLANE complex is the protein INTU (Inturned). Mutations in the *INTU* gene result in ciliary atrophy and are linked to severe ciliopathies, including Oro-facial-digital syndromes (OFDS) with severe polydactyly, polycystic kidney disease, and neural tube defects [2].

To investigate the cellular implications of a specific *INTU* mutation, we engineered a robust mammalian expression vector. The initial mutagenesis was performed within a pUCIDT backbone to establish a stable and verified mutant construct. To enable robust downstream expression and localization analysis, the mutant *INTU* insert (2831 bp) was subsequently subcloned into a pcDNA mammalian expression vector engineered with an HA-FLAG tag. The molecular cloning strategy required double restriction digestion using EcoRI and XhoI. A significant technical bottleneck arose during agarose gel extraction, as the 2831 bp insert was indistinguishable from the similarly sized 2764 bp pUCIDT vector backbone once the digestion was performed. To resolve this, a supplementary digestion utilizing SspI-HF was implemented to fragment the backbone, allowing for the clean isolation of the intact insert. Following the optimization of ligation and transformation protocols, the successful integration of the mutant sequence was achieved, generating the final 8309 bp pcDNA-HAFLAG-INTU (mut) construct. This validated vector now serves as a critical tool for our upcoming transfections in U87 cells, providing the necessary basis for assessing the phenotypic impact of the *INTU* mutation on ciliogenesis and cellular pathways.

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POSTER SESSION II

SERS detection of emerging contaminants in water

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The presence of emerging contaminants in freshwater ecosystems poses a significant environmental challenge. In this work, we demonstrate the highly sensitive detection of three widespread emerging contaminants—carbamazepine, diclofenac^{1,2}, and cypermethrin³—in aqueous media using Surface-Enhanced Raman Scattering (SERS). The SERS substrates were fabricated through a straightforward drop-casting method, depositing a dispersion of spherical gold nanoparticles onto silicon substrates in the presence of varying concentrations of the target analytes. Through this simple preparation process, we developed highly effective SERS platforms capable of detecting these molecules at trace levels. We successfully achieved detection limits down to 1E-8 M (approximately 2 µg/L) for the selected contaminants. These results underscore the immense potential of SERS for detecting emerging contaminants, even when employing simple and unoptimized substrates. Consequently, there remains a significant margin to further improve detection limits, paving the way for the future design of advanced sensors for real-time environmental monitoring.

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Theranostic Carbon Probes from non-conventional Marine Sources; Development and Validation

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The valorization of marine-derived waste offers a promising strategy for the development of sustainable nanomaterials within the framework of a circular economy [1]. In this study, lipid extracts from marine by-products were explored as unconventional precursors for the synthesis of carbon dots (CDs). Among the extracts tested, lipids derived from tuna skin exhibited the most suitable properties for the reproducible synthesis of CDs and were selected for further optimization [2].

CDs were synthesized by microwave-assisted carbonization, with reaction conditions optimized by varying solvent composition, surfactant, pH, reaction time, and urea and citric acid concentrations [3]. Tween 80 (surfactant) improved lipid dispersion; urea was essential for the formation of fluorescent CDs; and citric acid contributed to surface carboxylation through the introduction of COOH groups. The resulting CDs were physicochemically and morphologically characterized by DLS, zeta potential, UV-Vis spectroscopy, photoluminescence spectroscopy, FTIR, and TEM, and selected based on its intense blue fluorescence emission, small particle size, and more negative zeta potential [4].

To further enhance their diagnostic potential, manganese-doped CDs, were prepared using the same synthetic approach as candidates for multimodal imaging (MRI/OI) [5]. Their magnetic behavior was evaluated using VSM, and relaxometry measurements were performed to assess their effect on T_1 and T_2 relaxation times. In parallel, transferrin conjugation was explored as a strategy to promote active targeting of neuroblastoma cells. CDs are particularly attractive for neuroblastoma diagnosis and treatment due to their intrinsic fluorescence, tunable surface chemistry, and capacity to incorporate imaging or therapeutic elements may support tumor visualization, targeted delivery, and image-guided therapy [6]. Biological validation is currently underway on SK-N-BE(2) neuroblastoma cells. Cytotoxicity assays were performed on transferrin-functionalized Mn-CDs at 24- and 48-h. After identifying non-cytotoxic working concentrations, internalization and bioimaging assays were performed, taking advantage of the intrinsic blue fluorescence of Mn-CDs and their relaxometric properties. ROS generation assays are currently being developed to evaluate the therapeutic potential of Mn-CDs for photodynamic therapy through the induction of oxidative stress. Overall, this work proposes a sustainable, marine-waste-derived theranostic platform that combines fluorescence bioimaging, MRI-enhancing properties, tumor targeting, and ROS-mediated photodynamic therapy for applications in neuroblastoma.

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α -BCL6 nanoparticles for intracellular delivery in lymphoma treatment.

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Diffuse Large B Cell Lymphoma (DLBCL) is the most common B cell non-Hodgkin lymphoma and an aggressive disease that remains incurable in approximately 40% of cases. A key factor in its pathogenesis is the overexpression of B cell lymphoma 6 protein (BCL6), a transcriptional repressor which promotes B cell proliferation and survival, thereby contributing to lymphomagenesis. Since DLBCL cells strongly depend on BCL6 activity, the delivery of α -BCL6 monoclonal antibodies (mAbs) to the cell nucleus represents a promising therapeutic strategy; however, the inability of mAbs to efficiently cross the cell membrane remains a major limitation.

In this context, we aim to develop nanocarriers loaded with α -BCL6 mAbs (produced at CNIO) capable of enabling intracellular and intranuclear delivery, with the ultimate goal of improving the treatment of DLBCL. In this project, two different nanocarrier prototypes (NCs) were designed with the ability to associate antibodies and functionalized to facilitate the nuclear delivery in tumor cells. These systems were physicochemically characterized, and their antibody association efficiency, stability, and performance in relevant DLBCL cellular models were evaluated.

The developed nanocarriers successfully encapsulated α -BCL6 mAbs while showing a size range of 70 to 150 nm, a homogeneous polydispersity index (PDI) below 0.25, and a surface charge ranging from neutral to negative. The formulations also demonstrated high stability for up to one month at 4°C storage conditions, and exhibited low cytotoxicity in Farage and DOHH2 cell lines (both BCL6-dependent). Studies are undergoing to determine α -BCL6 nuclear delivery and therapeutic efficacy.

The preliminary results provide a basis for the further evaluation of BCL6 inhibition as a potential targeted therapeutic approach in lymphoma.

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COP/AuNP Platform for SERS-Based Detection of Saxitoxin

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Harmful algal blooms (HABs), rapid proliferations of toxin-producing phytoplankton, contribute to thousands of intoxication cases annually [1]. Among the toxins produced during HAB events, saxitoxin (STX) stands out as one of the most prevalent and potent one, causing paralytical shellfish poisoning (PSP), a neurotoxic syndrome that can lead to respiratory paralysis and death. Through bioaccumulation in shellfish and other filter-feeding organisms, STX easily propagates through the food chain, posing threats to seafood safety and public health. These risks highlight the urgent need for cost-effective, real-time, and *in situ* monitoring approaches to mitigate contamination events.

Surface-enhanced Raman scattering (SERS) has emerged as a powerful analytical technique for biotoxin detection, offering high sensitivity, molecular specificity, and rapid on-site measurement capability. However, implementing SERS for hydrophilic toxins with intrinsically low Raman cross-sections, such as STX, requires hybrid materials that combine strong plasmonic enhancement with selective molecular recognition to concentrate and/or bind the target analyte near the plasmonic surface.

Here, we report a hybrid material based on the covalent organic polymer TpPa-COOH, previously shown to exhibit high affinity for STX [2]. SERS performance of the hybrid was evaluated using a microfluidic chamber, enabling controlled and reproducible measurements. Under these conditions, oxidized STX was successfully detected down to 100 nM. These results demonstrate the potential of COP/AuNP hybrids for trace toxin detection and encourage their development toward integrated sensing platforms.

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Chiral Covalent Organic Frameworks as Catalyst Supports for the Oxygen Evolution Reaction

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Covalent organic frameworks (COFs) are crystalline porous materials with highly tunable structures and functionalities, making them promising platforms for catalytic applications. Their high surface area, ordered porosity, and chemical versatility facilitate the anchoring and dispersion of active species within their channels.^[1] Chirality can be introduced into COFs through the use of sub-stoichiometric amounts of enantiopure amines during synthesis, directing framework crystallization toward a preferred handedness without remaining in the final structure.^[2] This strategy has expanded the use of COFs in enantioselective catalysis and spin-dependent phenomena.

Recently, chiral COFs have attracted attention as efficient platforms for the chirality-induced spin selectivity effect, in which chiral materials behave as spin filters.^[3] This effect is particularly relevant for the oxygen evolution reaction (OER), where chiral catalysts can facilitate the formation of triplet ³O₂ from singlet water, enabling improved electrocatalytic performance.

Herein, we report on the chiral induction of TpBD-Me₂ COF using chiral amines as chiral inductors. RuO₂ was deposited onto the chiral COFs to yield hybrid electrocatalysts while retaining the chirality and order of the COF. The electrocatalytic activity of the chiral hybrids toward OER was evaluated under alkaline conditions, revealing lower overpotentials compared with achiral analogues, consistent with a CISS-mediated enhancement. These results demonstrate the potential of chiral COFs as versatile and accessible scaffolds for engineering spin-polarized heterogeneous electrocatalysts for sustainable water oxidation.

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Efficient Adsorption of Fluoroquinolone Antibiotics from Water by a Covalent Organic Framework

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The persistence of fluoroquinolone antibiotics in aquatic environments, due to their high consumption and inefficient removal by conventional wastewater treatment processes, represents a significant environmental concern [1]. Therefore, the development of efficient materials for the monitoring and extraction of these contaminants from water is highly desirable. Covalent organic frameworks (COFs) have emerged as promising materials for water monitoring due to their high surface area, tuneable porosity and customizable chemical properties [2]. In particular, the fluorinated TpBD-(CF₃)₂ COF was evaluated for the adsorption of enrofloxacin, one of the most widely used fluoroquinolones [3].

The COF showed efficient adsorption of enrofloxacin, reaching equilibrium within 4 h and an adsorption capacity of 31.5 mg g⁻¹, outperforming several conventional adsorbents. Desorption using isopropanol enabled ≈80% of recovery of the adsorbed antibiotic and good recyclability over five adsorption–desorption cycles. Furthermore, TpBD-(CF₃)₂ also showed efficient adsorption of a mixture of ten quinolones, with no significant competition effects at environmentally relevant concentrations (50 µg L⁻¹). Importantly, the extraction efficiency was retained in both river and sea water, highlighting the potential of the COF for the monitoring and concentration of fluoroquinolone antibiotics from natural water samples.

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Mixed-Linker Strategy for Pore Surface Tuning of Covalent Organic Frameworks

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Covalent organic frameworks (COFs) are a class of purely organic and crystalline nanoporous materials formed by stacked layers of planar sheets linked through reversible covalent bonds.¹ Their high crystallinity, low density, permanent and uniform pore structure, and remarkable structural diversity make these materials of growing interest for a wide range of applications.^{2,3} As opposed to the typically used post-synthetic modification procedures, mixed-linker strategy is an interesting alternative to tune the functionality of the COF pore surface. In this approach, a combination of two differently functionalized monomers are reacted with a node to give access to a single COF structure with increased structural complexity.⁴

In this study, the pore surface of TAPB-DMTP, a water-stable imine-linked COF resulting from the condensation reaction of 1,3,5-tris(4-aminophenyl)benzene (TPB) and 2,5-dimethoxy-1,4-benzenedicarboxaldehyde (DMTP), is modified through gradual introduction of a more hydrophilic building block, 2,5-dihydroxy-1,4-benzenedicarboxaldehyde (DHTA), to increase polarity of the COF pore surface. The physicochemical and optical properties were found to systematically change with increasing quantity of the more polar linker. This work establishes the mixed-linker strategy as an effective approach for accessing COFs with desired characteristics.

Acknowledgements

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Ag@PS-Decorated Nanofibers for Ultra-Sensitive Antibiotic Detection in Water

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The prevalence of antibiotics in aquatic ecosystems has emerged as a critical global environmental threat. These contaminants, even at trace levels, accelerate the development of antibiotic-resistant bacteria, jeopardizing public health and ecosystem stability. Consequently, there is an urgent need for rapid, ultra-sensitive monitoring tools. This work presents the development of flexible SERS (*Surface-Enhanced Raman Scattering*) substrates designed for the high-performance detection of pharmaceutical residues.

Silver (Ag) nanoparticles were interfacially assembled onto polystyrene (PS) spheres to fabricate SERS-active architectures. The resulting Ag@PS templates were subsequently embedded within a polymeric matrix and processed by electrospinning to obtain self-standing composite membranes featuring a highly interconnected three-dimensional nanofibrous network. By maximizing the effective surface area and leveraging the plasmonic amplification of the embedded hotspots, this platform aims to achieve exceptionally low limits of detection for pharmacological pollutants. Ultimately, this approach offers a versatile and scalable solution for in situ water quality control, surpassing the sensitivity of conventional Raman techniques.

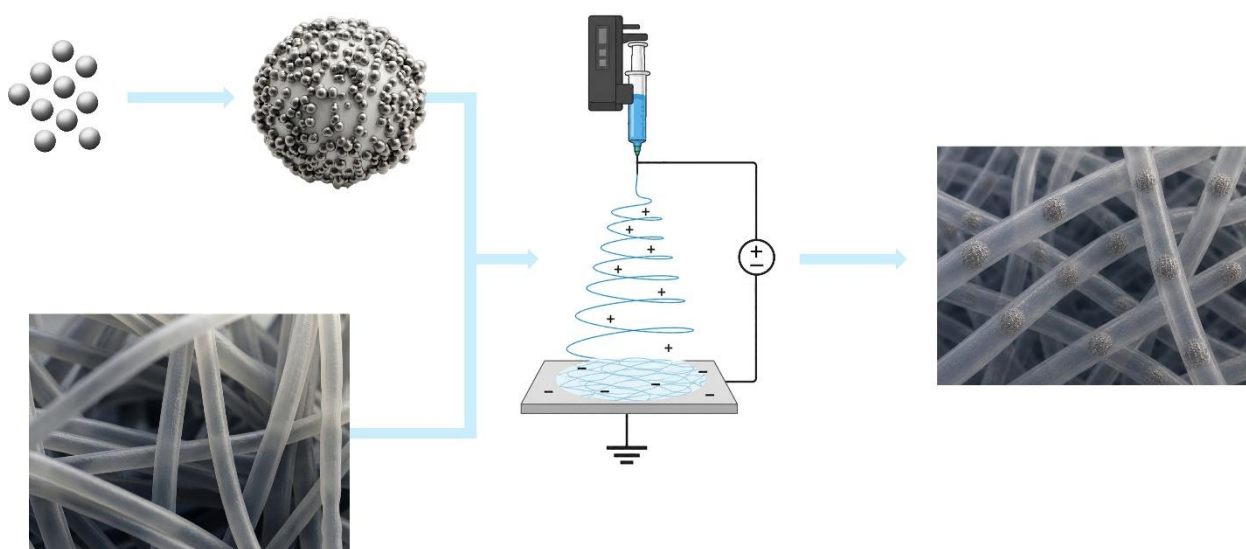


Figure. Material methodology graphical abstract.

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Context-Dependent Neurotoxicity of Medicinal Plant Phytochemicals via Convergent CNS Signaling Pathways

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Despite the widespread therapeutic use of medicinal plants and phytochemical-based formulations, their neurotoxicological safety profiles remain poorly characterized. Both neuroprotective and neurotoxic responses can be driven by secondary metabolites from plants with medicinal properties that target neuronal ion channels, mitochondrial bioenergetics, redox-sensitive signaling cascades, pro-inflammatory pathways, and transcriptional regulation. Common injury pathways include mitochondrial damage, oxidative stress (OS), DNA/transcriptional damage, membrane permeability changes, and apoptosis. Mechanistic elucidation is critical for identifying these potential neurotoxic plants and developing strategies to mitigate their harmful effects. A PRISMA-compliant review of bibliographic databases was implemented. A total of 42 peer-reviewed articles were included. Eligible studies evaluated neurotoxic effects of plant-derived medicinal extracts and secondary metabolites under *in vitro*, *in vivo*, or *in silico* models. Data were curated focusing on molecular mechanisms of action, toxicokinetic parameters (ADME profiles), and quantitative and qualitative neurotoxicity endpoints. We aimed to evaluate the potential hazards of medicinal plants to inform risk assessment and support safe therapeutic use of phytochemicals. Data converges to show neuronal toxicity with excitotoxicity, OS, mitochondrial dysfunction, and cellular metabolic processes of compounds. Bioactive phytoconstituents, including quercetin, and kaempferol, triggered DNA genotoxicity, mutagenesis, hepatotoxicity, and nephrotoxicity under preclinical testing conditions. Depending on their structure-activity relationship (SAR), dose-response dynamics, and exposure conditions, phytochemicals exhibit either neuroprotective or neurotoxic properties. Modulating canonical intracellular signaling pathways (e.g., JAK/STAT, IRS/PI3K, Ras/Raf/MAPK, and Nrf2–ARE) and neurotransmitter systems dynamics (e.g., GABAergic, glutamatergic, and cholinergic) can demonstrate how these compounds modulate neuronal function and synaptic transmission. In a context-dependent manner, medicinal plant constituents can promote or impair brain function. Studies have revealed this dualistic pharmacodynamic profile and highlighted advanced omics techniques that can assess risk and ensure the safe use of these plants.

Acknowledgements

The research leading to these results was supported by Xunta de Galicia for supporting the pre-doctoral grant of P. Barciela (ED481A-2024-230).

Stereoselective synthesis of decalpenic acid, a natural RAR γ agonist

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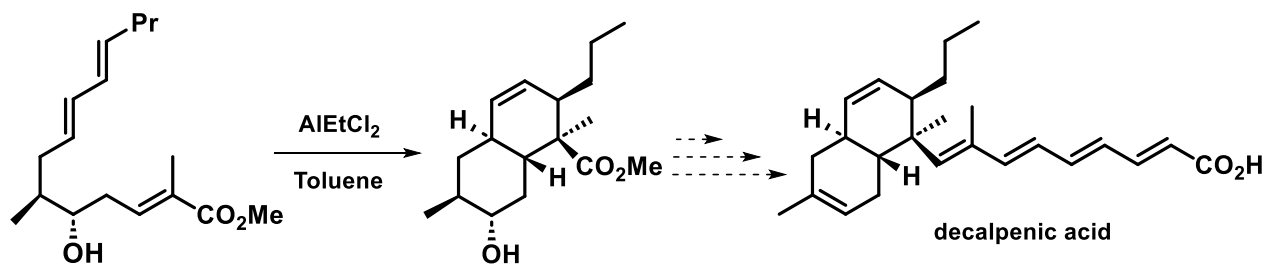
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Retinoids are a subgroup of β -apocarotenoids that play crucial roles in several biological processes, including vision, reproduction, cell differentiation, and immune function.¹

Decalpenic acid was isolated from the fermentation broth of *Penicillium verruculosum* CR37010 during a screening for inducers of osteoblast differentiation in mouse pluripotent mesenchymal C3H10T1/2 cells.² Structurally, decalpenic acid contains a decalin moiety linked to a tetraenoic acid side chain. The biological effects of decalpenic acid on C3H10T1/2 cells are like those of all-trans-retinoic acid and have been associated to RAR γ activation.

Our synthetic approach to decalpenic acid involves a vinylogous Mukaiyama aldol reaction to assemble the dienophile precursor, followed by an intramolecular Diels–Alder cycloaddition to construct the decalin framework,³ and the construction of the tetraenyl side chain.



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Probabilistic Dietary Risk Assessment of Mercury, Cadmium and Arsenic from Tuna Consumption in Portuguese and Spanish Adults

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Introduction: Portugal and Spain rank among the highest fish-consuming nations in Europe, with tuna representing a major dietary source of heavy metal exposure. Given the central role of the Port of Vigo in supplying tuna across the Iberian Peninsula, characterizing contaminant exposure in these populations is of particular public health relevance. **Aim and methodology:** This study aimed to probabilistically characterize dietary exposure to mercury (Hg), cadmium (Cd) and arsenic (As) from tuna consumption in adults from Portugal and Spain. Total Hg, Cd and As concentrations were determined by ICP-MS in 37 yellowfin tuna samples collected at the Port of Vigo and fitted to log-normal distributions. Consumption data were derived from IAN-AF 2015 (Portugal) [1] and ENALIA2 (Spain) [2] and modelled using gamma distributions fitted by percentile matching. Monte Carlo simulation (n = 10,000 iterations) was used to propagate uncertainty across both inputs simultaneously. **Results:** Hg exceedance of the EFSA TWI (1.3 µg/kg bw/week) occurred in 31.2% of simulated Portuguese consumers and 13.6% of Spanish consumers, with P95 hazard quotients of 3.12 and 1.66, respectively. Cadmium exposure was negligible relative to the TWI (2.5 µg/kg bw/week), with mean HQ below 0.02 in both populations. For arsenic, margin of exposure values fell below 10,000 across all scenarios and both countries, including sensitivity analyses at 5% and 10% inorganic arsenic fractions, indicating persistent concern even under conservative speciation assumptions. **Conclusions:** Tuna consumption represents a meaningful source of Hg exposure in both Iberian populations, with Portuguese adults at notably higher risk owing to greater habitual consumption. Cadmium posed no appreciable concern from this source. Arsenic warrants continued attention pending speciation data. These findings support the need for targeted dietary guidance for frequent tuna consumers in southern Europe.

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Neural mechanisms for stabilizing and goal-oriented eye movements in lampreys

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To perform advanced behaviors employing vision, mechanisms are necessary to stabilize the scene on the retina. One such mechanism is the optokinetic reflex, which is mediated by the pretectum (PT) [1, 2]. Additionally, these stabilization responses are modified to redirect gaze towards specific targets, a process in which the optic tectum (OT) plays a crucial role [2]. Here, we investigated the role of PT and OT in processing both optokinetic and non-optokinetic stimuli in the lamprey; an accessible animal model that enables *ex-vivo* preparations maintaining sensory organs. For this, we employed electrophysiology techniques in response to visual stimuli to investigate circuit connectivity and functionality (Figure 1). In adult lampreys, non-optokinetic visual stimuli elicited responses in both PT and OT. However, optokinetic stimuli induced sustained activation of neurons in the PT, while activity in the OT was short in duration, potentially due to the activation of the tectal GABAergic system [3]. Additionally, by using pharmacological perturbations, the OT and PT circuits were analyzed to unveil their interaction and individual contribution to gaze responses.

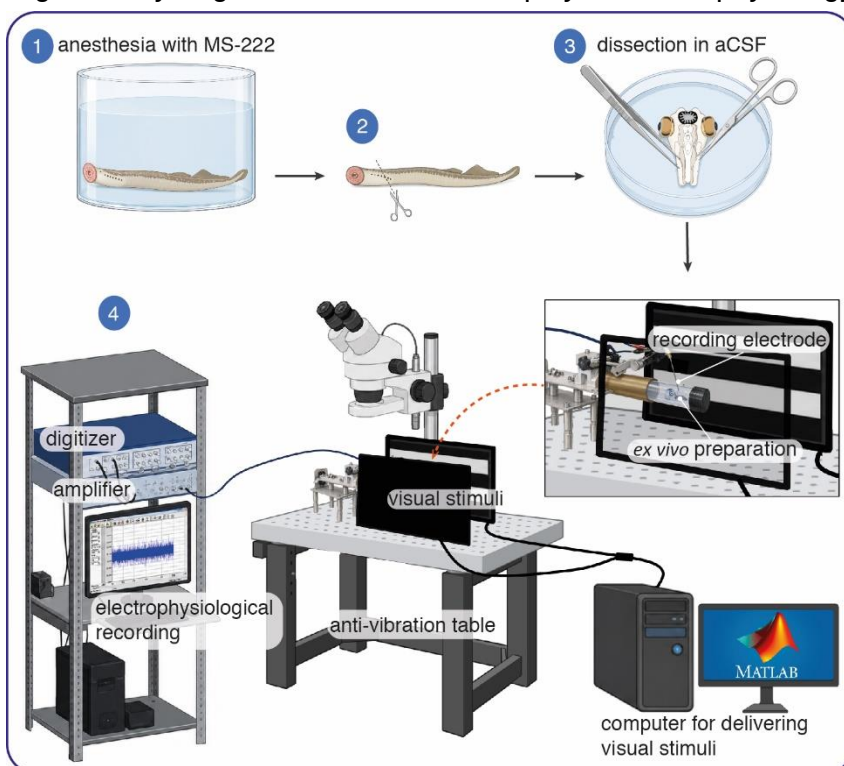


Figure 1. Methods. Abbreviations: aCSF, artificial cerebrospinal fluid. Created by the author using Biorender, with AI-assisted graphical refinement.

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Establishing mechanistic relationships of adaptogens by analyzing molecular pathways and bioactivity patterns using a database

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Background: Adaptogens (Adpt) are phytochemicals traditionally defined by their ability to enhance resilience to stress, although their mechanistic basis remains poorly defined ^{1,2}. Current evidence indicates that Adpt exert pleiotropic effects involving multiple stress-responsive pathways ². Although there are numerous studies focused on individual bioactivities, they are often studied in isolation, limiting the identification of unified criteria to define Adpt activity. **Objective:** To contribute to the mechanistic understanding of Adpt by establishing bioactivity-mechanism relationships. **Methods:** A curated dataset with 6 well-established adaptogenic species was developed. It includes information on reported bioactivities, associated molecular pathways and target groups (n= 49 research papers). Data curation and structuring were initially performed using Excel v16.26, followed by exploratory data analysis using Python v3.9.6 to identify recurring patterns and relationships among chemical features and bioactivity profiles. **Results and conclusions:** The analysis of the dataset showed NF-κB, MAPK, and PI3K_AKT as the main pathways identified, with 18.67, 13.33 and 9.33% of frequency, respectively. Among the analyzed bioactivities, antioxidant and anti-inflammatory, neuroprotective, antidiabetic, metabolic regulation, anticancer, immunomodulatory, anti-stress, and hepatoprotective) were identified as the most common among studied species. Inflammatory was also the most common target group, which is in accordance with the most common bioactivity among species. Finally, correlation analysis revealed consistent associations between oxidative stress-related pathways (i.e., Nrf2) and antioxidant bioactivity, as well as links between inflammatory pathways (i.e., NF-κB) and immunomodulatory effects, supporting the existence of interconnected stress-response networks in adaptogenic activity.

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Development of Nanoengineered Strategies to Cross the Blood-Brain Barrier for Alzheimer's Disease Therapy

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Alzheimer's disease (AD) is the leading cause of dementia worldwide, and no cure currently exists [1]. This reality is largely explained by the selective impermeability of the blood-brain barrier (BBB). Engineered nanoparticles (NPs), with tunable physicochemical properties and targeted surface functionalization, offer a powerful route to overcome this limitation. Here we report the synthesis and physicochemical characterization of two structurally distinct systems of increasing compositional, dimensional, and functional complexity, both functionalized with transferrin to exploit receptor-mediated transcytosis for BBB crossing [2]. The first consists of polyacrylic acid-coated superparamagnetic iron oxide NPs functionalized with transferrin (Figure 1A), serving as a proof-of-concept to assess the effectiveness of transferrin-mediated BBB crossing while providing magnetic resonance imaging contrast capability. The second approach involves the engineering of a magnetic theranostic platform designed to target a key hallmark of AD pathogenesis: the aggregation of β -amyloid peptides into neurotoxic plaques [3]. Magnetite and CRANAD-2 are co-encapsulated within a biocompatible carnauba wax matrix, equally functionalized with transferrin (Figure 1B). Here, the encapsulated magnetic NPs retain imaging functionality, while CRANAD-2 acts as the active pharmaceutical agent: upon BBB crossing and release, it enables near-infrared detection of β -amyloid plaques and actively promotes fibril disaggregation [4]. Together, these two strategies illustrate how rational NP design can integrate targeting, imaging, and therapeutic functions within a single system, advancing the development of effective therapies for AD.

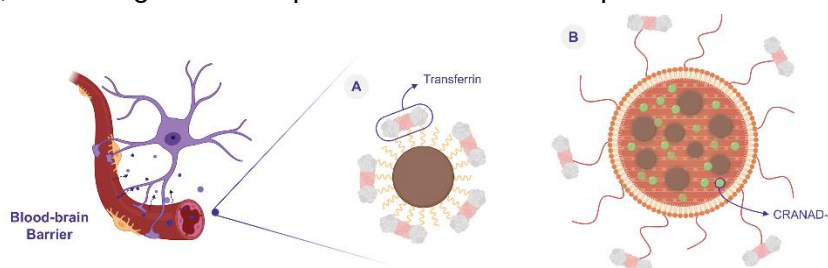


Figure 1. Transferrin-functionalized magnetic (A) and lipid-based (B) NPs designed for BBB crossing.

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Polymer-modified mesoporous silica nanoparticles for targeted intestinal delivery of entinostat

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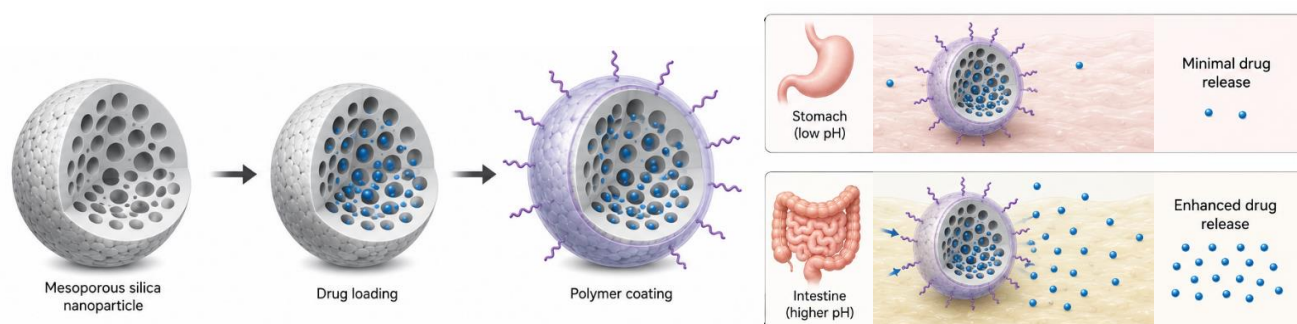
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Conventional therapies used for inflammatory bowel diseases (IBD) are limited by premature degradation of the therapeutic agents in the gastric environment and systemic toxicity due the lack of specificity and targeting of the drugs. To overcome these limitations, mesoporous silica nanoparticles (MSNs) have emerged as a promising strategy to improve the efficacy of the treatment and reduce the toxicity of the therapeutic agent [1].

In this study, MSNs were proposed as carriers for the controlled delivery of a histone deacetylase (HDAC) inhibitor drug, entinostat, with potential anti-inflammatory and immune-modulatory effects of IBD. The developed particles (64 ± 10 nm) were modified covalently and electrostatically with different polymers, chitosan [2] and poly(lactic-co-glycolic acid) (PLGA) to improve its mucoadhesive properties and enhance accumulation within the intestinal mucosa, to achieve a targeted and sustained drug release.

The MSNs exhibited high stability in simulated gastric medium, and degradation of the structure in simulated intestinal medium, after 24 hours of exposition. Furthermore, the particles presented excellent encapsulation efficiency of entinostat (approximately 95%) and enable a sustained release of entinostat, in both simulated fluids. Notably, the release was enhanced in intestinal simulated medium, compared to simulated gastric fluid over 72 hours.

Thus, MSN are presented as a carrier that allows for pH-controlled release with high potential for the application in treatments of inflammatory bowel diseases.



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Supramolecular Polymers Based on Asymmetrically Substituted Allene-based building blocks

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Supramolecular polymers represent unique classes of self-assembled architectures in which the constituent building blocks are held together through non-covalent interactions. Over the past decades, the development of chiral supramolecular derivatives has experienced remarkable growth, driven not only by the fundamental interest in understanding mechanisms of asymmetry induction and transfer, but also by their emerging applications in areas such as asymmetric synthesis, circularly polarized luminescence (CPL) sources, and spin-selective materials.

Herein, we report the synthesis, characterization, and aggregation behavior of a new family of supramolecular building blocks incorporating an axially chiral allene moiety as the asymmetry-inducing element, functionalized with distinct aggregation-promoting chains. The self-assembly properties of these building blocks were systematically investigated using a range of spectroscopic techniques, including UV–Vis absorption, electronic circular dichroism (ECD), infrared (IR), and fluorescence spectroscopy, among others. These studies provide valuable insight into the role of molecular chirality and peripheral substituents in directing supramolecular organization and modulating the resulting chiroptical properties.

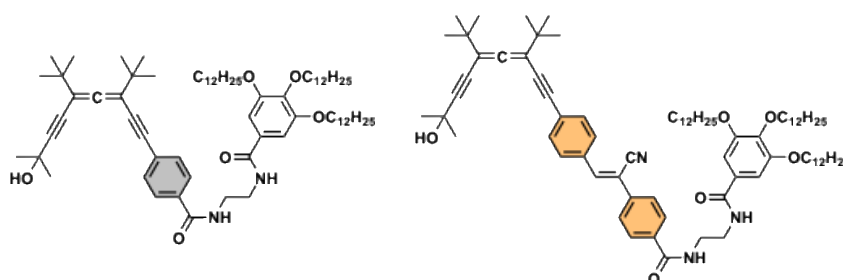


Figure 1. Structure of the derivatives studied in this study.

Acknowledgements

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Toward predictive and controllable T-cell activation models: identifiability and sensitivity analysis

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T-cell activation is a crucial process in the adaptive immune response, requiring both specificity in self-discrimination and sensitivity to low antigen concentrations. The complexity of this process has led to the development of various mathematical models that aim to describe and predict the conditions for antigen-TCR interactions required for TCR triggering and T-cell activation. These models are characterised by describing different sets of sequential molecular interactions and their kinetics, positing the generation of a final product as a necessary and sufficient condition for T-cell activation. A number of mathematical models of TCR-mediated T-cell activation have been proposed in the last few decades [1]. However, a fundamental challenge remains: neither the internal states nor the kinetic parameters of these models are directly measurable, raising key questions about their predictive and practical utility. This work addresses those questions through a systematic, structural, and numerical analysis of thirteen phenotypic T-cell activation models. We derive closed-form analytical expressions for two experimentally accessible response metrics, the peak response (E_{max}) and the ligand potency (EC_{50}), linking mechanistic model structure to observable outputs. Such equations could provide an effective tool for simulating antigen recognition by T cells and, consequently, aid in the design of effective therapeutic strategies. However, it is necessary to assess the predictive capabilities of the proposed models before fitting them to experimental data. As a first step towards this goal, we examine the parameter identifiability [2] and sensitivity [3] of the published models of TCR-based T-cell activation. For each model, we consider different, often experimentally measured, output quantities and show how their availability affects the results. These analyses allow us to determine each model's ability to correctly describe different experimental situations and to assess the extent to which these models can be applied to reliably predict and control T-cell activation by specific therapeutic targets.

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Ruthenium(II) *p*-cymene-Thiosemicarbazone complexes as Potential Agents against Triple-Negative Breast Cancer

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The clinical success of platinum-based anticancer drugs, such as cisplatin, is limited by their severe side effects and the emergence of resistance, prompting the search for alternative metal-based therapies. Among the metal-based alternatives, ruthenium complexes have emerged as promising candidates due to their favorable pharmacological properties (including lower toxicity, rich redox chemistry) and the ability to target both primary and metastatic tumors.¹

In particular, organometallic Ru(II)-arene complexes of the $[\text{Ru}(\eta^6\text{-arene})\text{L}_x]$ type have attracted considerable attention due to their structural versatility and tunable biological activity. The incorporation of bioactive ligands such as thiosemicarbazones (TSCs), which coordinate through N,S donor atoms, offers additional advantages, as these ligands possess intrinsic anticancer properties and can modulate the stability, reactivity, and cellular uptake of the resulting complexes.²

Triple-negative breast cancer represents an aggressive subtype of breast cancer with limited therapeutic options. The MDA-MB-231 cell line is a widely used model for this disease, characterized by high invasiveness and resistance to conventional treatments, making it particularly suitable for evaluating new anticancer agents.

In this work, we report the synthesis and characterization of a series of Ru(II) complexes with the general formula $[\text{Ru}(\eta^6\text{-p-cymene})(\kappa^2\text{-N,S-TSC})]$ in addition to the study of their behavior under physiological conditions and their cytotoxic activity *in vitro* against MDA-MB-231 cells.

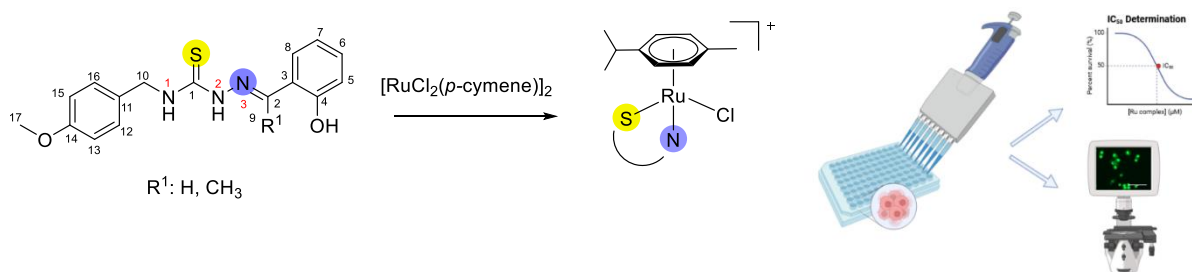


Figure: Synthesis Scheme and biological studies.

Acknowledgements

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Uncovering early joint disease biomarkers through synovial fluid extracellular vesicle subpopulation analysis

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Osteoarthritis (OA) is a degenerative joint disease characterized by chronic pain and progressive loss of mobility. A key unmet need is the identification of early biomarkers. Connexin43 (Cx43), a membrane protein involved in cell communication and senescence, is a key regulator of joint homeostasis and is upregulated early in OA, independently of phenotype. Our group has shown that Cx43-enriched extracellular vesicles (EVs) from osteoarthritic chondrocytes contribute to inflammatory and degenerative joint processes. Here, we analyse synovial fluid EVs to identify disease-relevant biomarkers in rheumatic and degenerative joint disorders. EVs were isolated using density-gradient ultracentrifugation (MISEV2023-compliant) and characterized by NTA, Western blot, microscopy, and high-resolution flow cytometry (FC). FC enabled sorting of EV subpopulations based on Cx43 and markers (CD3, CD14, CD90) and dyes (Aco490, PI, DRAQ5). Sorted EVs were subjected to proteomic, transcriptomic, and genomic analyses. We observed strong heterogeneity in synovial fluid EVs and identified distinct marker-defined subpopulations across joint diseases. Cx43-positive EVs were consistently present in inflammatory and degenerative conditions, supporting their role as a general marker of joint pathology. EV sorting enabled enrichment of disease-specific subsets and identification of molecular signatures linked to OA and other disorders. This approach establishes Cx43+ EVs as a biomarker platform and demonstrates that high-resolution EV sorting combined with multi-omics enables discovery of clinically relevant signatures for early diagnosis and classification of joint diseases.

Dual Antitumour and Immunomodulatory Activity of a Novel Target in Triple-Negative Breast Cancer

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Triple-negative breast cancer (TNBC) is an aggressive subtype of breast cancer with limited therapeutic options. Approximately 15–20% of TNBC patients harbor BRCA mutations. BRCA genes are involved in DNA repair, and their mutation leads to increased DNA damage accumulation in tumor cells. PARP is another protein involved in DNA repair pathways, and PARP inhibitors such as olaparib have shown efficacy in BRCA-mutated tumors by further impairing DNA repair mechanisms. However, resistance remains a major clinical challenge. Connexin 43 (Cx43) has emerged as a potential regulator of this process due to its involvement in DNA repair processes at the nuclear membrane. Here, we aimed to investigate the activity of Cx43 and their potential therapeutic role in TNBC-BRCA under PARP inhibitor treatment. To this end, human BRCA1-mutated TNBC HCC1937 cells partially resistant to olaparib were transfected with a vector restoring Cx43 expression (HCC-Cx43) and compared with empty vector controls. Functional assays showed that Cx43 reexpression reduced clonogenic capacity and increased sensitivity to olaparib compared with control cells. Colony formation assays and flow cytometry analyses revealed a significant reduction in cell survival in HCC-Cx43 cells alone and following olaparib treatment, supporting a role for Cx43 in enhancing therapeutic response. To evaluate the role of Cx43 in anti-tumor immune activity, co-culture assays with NK-92 cells were performed. Preliminary results suggested increased NK cell-mediated cytotoxicity in HCC-Cx43 cells compared with control cells, particularly under olaparib treatment. Flow cytometry and parachute assays showed that this mechanism partially depends on the interaction and formation of gap junctions between NK cells and tumor cells. In addition, EVs from HEK293 cells modified to overexpress Cx43 led to the production of EVs enriched in Cx43 that, when used to treat HCC cells, led to reduced colony formation associated with an increase in Cx43 mRNA and protein. Overall, our results support the therapeutic relevance of Cx43 restoration in BRCA1-mutated TNBC and provide preliminary evidence for the development of EV-based Cx43 delivery strategies.

Identification and Analysis of CAR-T Cell Therapy Models

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CAR-T cell therapy is a promising immunotherapeutic strategy whose dynamics involve complex interactions between tumour cells, immune populations and cytokine-mediated responses. Mathematical models can support treatment understanding and optimization, provided their inference and control properties are well characterized. In this work, two ODE-based CAR-T therapy models were analysed: HCART [1], describing tumour–CAR-T interactions, and CRS [2], incorporating macrophage activation and cytokine release syndrome dynamics. A systematic framework combining structural identifiability, observability, controllability, accessibility, practical identifiability and sensitivity analyses was applied to evaluate their suitability for parameter estimation and therapy design.

Structural analyses identified inference limitations in both models, with the CRS model exhibiting several non-identifiable parameters and partially observable states. After reformulation to include CAR-T dosage as an external input, the HCART model was found to be accessible and locally controllable, whereas the CRS model remained accessible but non-controllable. Practical identifiability analyses revealed examples of identifiable, bound-active and non-identifiable parameters, highlighting discrepancies between structural and practical inference capabilities. Sensitivity analyses further identified a reduced subset of parameters with dominant influence on system dynamics.

Overall, the results provide a comprehensive assessment of the inference and control properties of CAR-T therapy models, helping to identify model limitations and supporting the development of more reliable model-based therapeutic strategies.

Acknowledgements

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Phenolic-rich extracts from Camellia Flowers and Chestnut Shells: potential active ingredients for topical applications

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Innovative extraction technologies show promising results in obtaining high-added-value compounds from plant-derived substrates and even waste. Plant-derived bioactive extracts often exhibit strong antioxidant and antimicrobial properties due to their rich composition [1].

Camellia japonica flowers were submitted to a sequence of microwave hydrodiffusion and gravity, sc-CO₂ extraction, and microwave assisted extraction (temperatures from 120 to 200 °C), to optimize bioactive compounds recovery. Sc-CO₂ extracts presented 36.63 mg Trolox eq/g dry extract and 8.57 mg ascorbic acid eq/g dry extract as antioxidant activity. As to microwave extracts, total phenolic content and antioxidant activity peaked at 200 °C, reaching 220 mg GAE/g dry extract and 285 mg Trolox eq/g dry extract. However, as expected, anthocyanin content peaked at the lowest temperature (120 °C, 0.3 mg cyanidin-3-O-glucoside eq/g petals), increasingly being reduced at higher temperatures than 140 °C.

Ground chestnut inner shells were microwave-extracted (170 °C, 2.5 min) to obtain a phenolic-rich extract for later membrane fractionation. Total phenolic content reached 148 mg GAE/g dry extract and antioxidant activity 801,4 mg Trolox eq/g dry extract). The extract was fractionated by membrane filtration, and the most bioactive fractions (5–100 kDa and 1-5 kDa) as well as an original extract were retained for antimicrobial assessment. For *Camellia japonica* flowers a minimum inhibitory concentration (MIC) value of 8 mg/mL was found as to the 200 °C extract, whereas 12 mg/ml were the MIC values of 140 and 180 °C extracts. Similar results are found in literature in other plant matrices [2]. Only 50–100 kDa fraction of Chestnut inner shells extract consistently inhibited *Staphylococcus epidermidis* in agar diffusion assays, producing a well-defined inhibition zone of 1.2–1.4 cm at 10 mg/mL.

Results demonstrate the feasibility of *Camellia* flowers for future applications, due to their hydrophobic and hydrophilic components. The remaining solid waste could be explored for biocomposite materials. The selective activity of the 50–100 kDa fraction of chestnut shell extract against *Staphylococcus epidermidis* suggests its potential as an active ingredient in topical formulations such as O/W creams or polyphenol-based hydrogels for skin infection management [3].

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Connexin 43–Enriched Extracellular Vesicles as a Therapeutic Platform with Enhanced Uptake and Antitumour Activity

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Connexin 43 (Cx43) is a transmembrane channel protein with additional non-canonical and nuclear functions that has emerged as a relevant therapeutic target in cancer. We recently demonstrated (Nature Communications, 2025) that Cx43 upregulation in BRAF-mutant melanoma enhances tumour cell death by interfering with DNA damage response pathways, thereby increasing the efficacy of targeted therapies and overcoming drug resistance, one of the major challenges in cancer treatment. As Cx43 is incorporated into extracellular vesicles (EVs), we explored the potential of engineering Cx43-enriched EVs as a protein-based therapeutic delivery system.

We engineered producer cells to generate EVs enriched in Cx43, which contained increased levels of both Cx43 protein and mRNA. Uptake of Cx43-enriched EVs by tumour cells was significantly higher than that of control EVs and comparable to the effects achieved through viral-mediated Cx43 upregulation. Notably, Cx43-enriched EVs induced tumour cell death more efficiently in BRAF/MEK inhibitor-resistant cells than in drug-sensitive cells, highlighting their potential to target therapy-resistant populations.

High-resolution imaging revealed that Cx43 localises to large cytoplasmic vesicular structures consistent with annular gap junctions, which were identified as multivesicular bodies co-expressing the late endosomal marker CD63. While overall EV release was not altered by Cx43 expression, Cx43-expressing cells released a higher proportion of CD63-positive EVs, suggesting preferential exocytic secretion of specific EV subpopulations. In addition, EVs displayed DNA associated with their external surface, supporting a potential role for EV-associated DNA in membrane–membrane interactions and cellular uptake. Metabolomic profiling further identified distinct metabolic signatures in Cx43-enriched EVs that may contribute to their antitumour activity.

Together, these findings demonstrate that Cx43 upregulation in producer cells promotes the formation and release of CD63-positive, Cx43-enriched EVs with enhanced uptake and potent antitumour effects, particularly in therapy-resistant tumour cells. These results position Cx43-enriched EVs as a promising non-viral therapeutic delivery platform for the development of novel cancer treatment strategies.

Remote Control System for Mineral-Medicinal Waters Using Artificial Intelligence (AQUAPRED)

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AQUAPRED is a multi-territorial, multidisciplinary, and interdisciplinary project involving physics, medicine, pharmacy, chemistry, biology, and computer science. It focuses on the monitoring and control of mineral-medicinal waters in spas and on the prediction of contaminants based on the real-time digitization of key parameters of these waters.

The project will determine the fundamental parameters of thermal spas, as well as their fluctuation ranges within the thermal water of a spa facility. It will also study their influence on therapeutic safety and water quality, as well as potential models of their relationship.

The project will establish a hydrobiome model of the waters in thermal spas and associate it with their therapeutic properties. Pilot systems for real-time data collection will be developed and installed in spas in the SUDOE area. The parameters will be monitored using devices specifically designed for this purpose, for subsequent digitization and analysis. An intelligent system will be developed that, based on this data, will allow for the control of water treatment elements, along with a deep learning model that will predict the potential appearance of contaminants in the water. Energy efficiency models will also be applied based on the captured data to optimize consumption and reduce demand.

Acknowledgements: Work supported by the Interreg - Sudoe program, AQUAPRED, a network of French, Spanish and Portuguese actors working on the creation of an Artificial Intelligence tool to monitor the quality and control of thermal waters in real time.

Viral infections accelerate host aging

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Viral infections can induce symptoms reminiscent of aging, but their impact on the host's biological age remains unclear. Using data from model organisms (the fly *Drosophila melanogaster* and the nematode *Caenorhabditis elegans*) we investigated the effects of various enteric viruses on aging. Employing computational methods on transcriptional data to estimate biological age, we revealed that viral infections accelerate aging in flies. Infections by more virulent viruses resulted in a steeper acceleration of aging compared to less virulent ones. Remarkably, viral infections led to significant aging acceleration even after viral clearance, highlighting the long-term consequences of viral infections. Furthermore, our findings demonstrate that enteric viral infections induce systemic aging beyond localized intestinal pathology, as evidenced by perturbed biological age estimations across distinct host tissues. Ultimately, this work establishes viruses as age-distorters and provides a robust foundation for further research into the interaction between viral infections and the aging process.

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Generalized Additive Models for Atrial Fibrillation Detection in ECG Signals

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Atrial fibrillation (AF) is one of the most prevalent cardiac arrhythmias worldwide and is strongly associated with increased risks of stroke, heart failure, hospitalization, and mortality. Early and accurate diagnosis is therefore essential for improving patient outcomes and supporting preventive clinical interventions.

This study addresses the discrimination between AF patients and healthy subjects using electrocardiographic (ECG) data from the PTB-XL database (PhysioNet) [1]. A balanced subset of 300 ECGs (150 AF, 150 controls) was randomly sampled. From the original 532 variables, a reduced set of clinically relevant features was selected, focusing on parameters associated with atrial activity, ventricular conduction, and rhythm regularity [2], [3], including PR interval, P wave duration and amplitude, QRS duration, QT intervals, R and T wave amplitudes, and mean RR interval. Demographic covariates (age and sex) were also incorporated, given their well-established relationship with AF prevalence and their role in improving model generalization.

To identify the most informative subset of variables, a novel feature selection methodology based on logistic Generalized Additive Models (GAMs) [4] was employed. This approach allows modelling nonlinear relationships between predictors and the response variable while maintaining interpretability. Model performance was evaluated using the Bayesian Information Criterion (BIC) and the Area Under the Receiver Operating Characteristic Curve (AUC), balancing goodness-of-fit and model complexity. The proposed method consistently identified compact models with high predictive performance. One of the best-performing models included only three variables (the duration of the P wave, the mean length of the RR intervals across all leads, and the age), achieving an AUC of 1.0 on the training set and 0.98 on the test set.

The findings demonstrate that accurate discrimination between AF patients and healthy individuals can be achieved using a very limited number of interpretable features. The proposed GAM-based framework provides a transparent and flexible approach capable of capturing nonlinear effects while maintaining interpretability, making it suitable for clinical applications and decision-support systems.

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Microfluidic Fabrication of Nanostructured Hydrogel Microfibers Recreating Tendon Anisotropic Architecture and Cellular Patterns

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Tendons are challenging tissues to repair, largely because their remarkable biological and mechanical function relies on a highly anisotropic cellular and fibrillar architecture. Microfluidic spinning has been proposed as a technology to fabricate hydrogel-based fibre constructs that recreate this architecture and cell organization. However, current microfluidic spinning approaches typically produce bulk or compartment confined cell-laden hydrogel microfibers that lack the nanoscale topographical and mechanical cues of native tendon extracellular matrix (ECM) microenvironment, known to play key roles on stem cells tenogenic commitment and maintenance of tenocyte phenotype.

To address this gap, we designed a novel quadrupole stream flow-focusing microfluidic device capable of continuously spinning nanostructured core-shell microfibers that structurally mimic the uniaxial anisotropy and cell-scale mechanical properties of tendon fascicles. This microfiber consists of a core made of rod-shaped cellulose nanocrystals uniaxially aligned by shear forces, providing nanoscale anisotropic topography and collagen fibril mimetic stiffness, surrounded by a platelet lysate-alginate hydrogel shell serving as a biologically supportive microenvironment for encapsulated human adipose-derived stem cells (hASCs). Continuous microfiber production is achieved by collecting the spun microfibers onto a rotating spool, while independent control over flow rates enables precise and on-demand tuning of core and shell dimensions, making this a robust and versatile biofabrication platform.

To probe the tendon-biomimetic potential of these microfibers, the behaviour of encapsulated hASCs was monitored over time. Remarkably, cells selectively anchored to the stiff anisotropic cores, adopting the elongated and aligned morphology characteristic of native tenocytes. This 3D contact guidance effect promoted focal adhesion activation, YAP/TAZ nuclear translocation, and progressive upregulation of key tenogenic markers downstream of mechanotransduction-driven signalling.

Together, these findings establish the proposed nanostructured core-shell microfibers as a biomimetic platform capable of recapitulating tendon fascicle architecture and cell patterns that directs stem cell differentiation. It offers not only a powerful tool for tendon *in vitro* modelling and tissue engineering but has broader implications for other tissues where ECM architecture and cell-scale mechanics synergistically governs cell behaviour.

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Characterization of Pressurized Hot Water Extraction of Bioactive Compounds from Mediterranean Seaweeds: *Chaetomorpha linum* and *Pterocladia capillacea*

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Mediterranean Seaweeds have garnered significant interest due to their rich of bioactive compounds, which are being explored for future food and nutraceutical industries [1,2]. Pressurized Hot Water Extraction (PHWE) represents an environmentally friendly alternative to conventional solvent-based extraction methods, as it employs water under elevated temperature and pressure conditions to improve solvent diffusivity, solubility, and mass transfer efficiency, thereby enhancing the recovery of bioactive compounds [3]. In the present study, the recovery of bioactive compounds from the green seaweed *Chaetomorpha linum* and the red seaweed *Pterocladia capillacea* was investigated using Pressurized Hot Water Extraction (PHWE). Different operational conditions, including extraction temperature and extraction time, were evaluated in order to determine their effects on extraction yield and the chemical composition of the obtained extracts. This study aimed to optimize the extraction process for the efficient recovery of valuable bioactive compounds from both seaweed species. The resulting extracts were characterized in terms of extraction yield, total phenolic content, antioxidant capacity (FRAP, TEAC, and DPPH assays), protein content, and sulfate content. Oligosaccharide composition was determined by HPLC following acid hydrolysis.

The results demonstrated that extracts obtained from Mediterranean seaweeds possess promising bioactive properties, highlighting their potential as natural ingredients for food and nutraceutical applications.

Acknowledgements

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