BOOK OF ABSTRACTS

SupraLife Second School

10 - 15 March 2024

University of Aveiro, Portugal

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COMPASS

ENGINEERING LIFE GUIDED BY NATURE

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WELCOME LETTER

Dear SupraLife Friends and Colleagues,

It is our pleasure to welcome you to the SupraLife Second School entitled "Bioinspired Supramolecular Self-Assemblies", which takes place from 10-15th March 2024 in the pleasant city of Aveiro, Portugal.

The Second School includes an outstanding scientific program from 10-12th March focusing on teaching fundamental-to-advanced concepts on the molecular design, synthesis, development, and advanced characterization of bioinspired supramolecular self-assemblies for biomedical and healthcare applications. The program will consist of 14 plenary lectures by world-renowned scientists well-known for their extensive expertise and experience in the supramolecular and biomaterials' chemistry fields, who will share their extensive experience and expertise and present a comprehensive overview of the research activities headed by their own research groups and in collaboration with other research groups, industry practitioners or clinicians. The lectures will cover the topics of bioinspired polymers, functional supramolecular self-assemblies, adaptive, dynamic, responsive and interactive soft materials and molecular systems, compartmentalized structures, life-like systems, and their use in nanomedicine, diagnostics, theranostics, biosensing, drug/therapeutics/cell delivery, soft robotics, tissue engineering or regenerative medicine. The scientific program will also include oral and poster presentations selected from contributed abstracts submitted by students and early-career scientists to enable them to share and discuss their scientific discoveries, interact closely and exchange ideas with peers. Awards will be given to the best oral communication and to the best three poster communications. The Meet-the-Mentor lunch time and the Young Scientists' Networking Forum will provide plenty of opportunities for young scientists to engage in fruitful conversations with the plenary speakers and to network with peers in an informal and relaxed atmosphere.

Moreover, the Second School will also include an exciting soft transferable skills' training program from 13-15th March aiming to advance the professional development and widen the career perspectives of students and early-career scientists, irrespectively on their background and research domain. The training program will feature 13 invited speakers, experts and highly skilled professionals covering a wide range of topics including *career routes, career development, scientific publishing and ethics, mental health and imposter phenomenon in academia, diversity, equity and inclusion in science, community building for scientists, science innovation, open science, project management and data management*. The invited speakers will provide the students and early-career scientists with the skills to thrive in their professional duties and career paths.

We would like to express our sincere thanks to the Plenary and Invited Speakers, Chairs and Moderators of the different sessions for their kind availability and for sharing their work and expertise. We extend our gratitude to the Oral and Poster presenters for sharing their work, as well as to all Attendees for joining us in Aveiro for the SupraLife Second School!

Moreover, we are also very grateful to the SupraLife's consortium partners, Associate Laboratory CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, as well as to all Sponsors for their invaluable support.

Last, but not least, a special thanks to the Local Organizing Committee for their tireless support, effort, commitment, and professionalism, and extremely important contribution to the success of this event.

We hope that you all find the SupraLife Second School stimulating and that you enjoy your stay in the beautiful city of Aveiro, and we look forward to meeting you soon!

The Chairs of the SupraLife Second School,

João F. Mano

João Borges

UNIVERSITY OF AVEIRO
CAMPUS MAP

Central and Rectorate Building
Auditorium Renato Araújo

Coffee Breaks and Poster Sessions
University Gallery - "Catacumbas"

14 minutes
walk to canteen

Lunch Breaks
Crasto Canteen Complex

SCIENTIFIC PROGRAM

10th March

Auditorium Renato Araújo – Central and Rectorate Building

12:00 - 14:00	Registration
14:00 - 14:15	**Opening Ceremony** **Artur Silva** (Vice-Rector for Research, Innovation and 3rd Cycle of the University of Aveiro, Portugal) **João Coutinho** (Director of CICECO – Aveiro Institute of Materials at the University of Aveiro) **João F. Mano & João Borges** (Coordinators of the SupraLife project at the University of Aveiro, Portugal)
Chairs: Bert Meijer (Eindhoven University of Technology, The Netherlands) **& Maria Lopes** (University of Aveiro, Portugal)	
14:15 - 15:00	**PL1. Olli Ikkala** (Aalto University, Finland) Towards life-inspired soft matter dynamics and functionalities
15:00 – 15:45	**PL2. Tanja Weil** (Max Planck Institute for Polymer Research, Germany) Chemistry in living systems: how structure formation controls cellular function
15:45 – 16:30	**Coffee Break & Poster Session**
Chairs: Silvia Marchesan (University of Trieste, Italy) **& Luca Capelli** (University of Parma, Italy)	
16:30 - 17:15	**PL3. Maartje Bastings** (École Polytechnique Fédérale de Lausanne, Switzerland) Rigidity at the nanoscale: engineering (super-)selective interactions with DNA
17:15 - 18:00	**PL4. João Borges** (University of Aveiro, Portugal) Self-assembling polymeric biomaterials: from molecular design to interactions with living systems
18:00 – 18:15	**OC1. Torsten John** (Max Planck Institute for Polymer Research, Germany) Peptide self-assembly and corona formation at the bio-nano interface
18:15 – 18:30	**OC2. Vijay Kumar Pal** (Institute for Research and Innovation in Health, University of Porto, Portugal) Harnessing the potential of supramolecular peptide nanomaterials to fuel anti-tumor immunity
18:30 – 18:45	**OC3. Artem Kononenko** (École Polytechnique Fédérale de Lausanne, Switzerland) Evolution of multivalent DNA-based supramolecular assemblies
18:45 – 19:00	**OC4. Vera Sousa** (University of Aveiro, Portugal) Dynamic protein-based G-quadruplex-derived supramolecular hydrogels as stable bioinks for healthcare
19:00 - 21:30	**Welcome Reception**

11th March

Auditorium Renato Araújo – Central and Rectorate Building

8:00 - 9:00	Registration
Chairs: Tanja Weil (Max Planck Institute for Polymer Research, Germany) **& Elisa Marelli** (Politecnico di Milano, Italy)	
9:00 - 9:45	**PL5. Tuomas Knowles** (University of Cambridge, United Kingdom) Functional artificial materials through self-assembly of natural peptides and proteins

11th March

Auditorium Renato Araújo – Central and Rectorate Building

Chairs: Tanja Weil (Max Planck Institute for Polymer Research, Germany) **& Elisa Marelli** (Politecnico di Milano, Italy)

9:45 - 10:30	**PL6. Cecília Roque** (FCT-NOVA University of Lisbon, Portugal) Opportunities from peptide and protein self-assembly in non-conventional solvents
10:30 - 11:15	**Coffee Break & Poster Session**

Chairs: Cecília Roque (FCT-NOVA University of Lisbon, Portugal) **& Sarah Chagri** (Max Planck Institute for Polymer Research, Germany)

11:15 - 12:00	**PL7. Colin Bonduelle** (University of Bordeaux, France) Polypeptides: from proteins to new approaches in polymer synthesis
12:00 – 12:45	**PL8. Silvia Marchesan** (University of Trieste, Italy) Chirality as a stargate in peptide-based biomaterials
12:45 - 14:45	**Lunch Break & Meet the Mentor**

Chairs: Nathalie Katsonis (University of Groningen, The Netherlands) **& Margarida Sacramento** (University of Aveiro, Portugal)

14:45 - 15:00	**OC5. Ana Sofia Pina** (ITQB-NOVA, Portugal) Peptide-induced coacervation: a path to enhanced catalysis and protocell mimicry
15:00 - 15:15	**OC6. Huichao Zhao** (Aarhus University, Denmark) Functionalized liposomes for intracellular ROS scavenging in steatotic hepatocytes
15:15 - 15:30	**OC8. Zhenwei Ma** (University of British Columbia, Canada) Printable tough adhesives with triggerable supramolecular interactions and extreme mechanical
15:30 - 15:45	**OC7. Eloïse Equy** (University of Bordeaux, France) Janus polymersomes: mimicking biological motility for drug delivery applications enhancement
15:45 - 16:45	**Coffee Break & Poster Session**

Chairs: Jan van Hest (Eindhoven University of Technology, The Netherlands) **& Man Him Chak** (UNSW Sydney, Australia)

16:45 - 17:30	**PL9. Arri Priimägi** (Tampere University, Finland) Light-driven soft actuators: multifunctionality and “life-like” characteristics
17:30 - 18:15	**PL10. Nathalie Katsonis** (University of Groningen, the Netherlands) Life-like morphological transitions in active droplets and protocells
18:15 - 19:00	**PL11. Rafal Klajn** (Institute of Science and Technology Austria (ISTA), Austria) Photochemistry within the confinement of a flexible coordination cage
19:00 - 23:00	**Young Scientists’ Networking Forum**

12st March

Auditorium Renato Araújo – Central and Rectorate Building

Chairs: Sébastien Lecommandoux (University of Bordeaux, France) **& Ane Bretschneider Søgaard** (Aarhus University, Denmark)

9:00 - 9:45	**PL12. Jan van Hest** (Eindhoven University of Technology, the Netherlands) Polymer-based artificial cells
9:45 - 10:30	**PL13. Brigitte Städler** (Aarhus University, Denmark) Artificial cells and their interaction with mammalian cells
10:30 - 11:15	**Coffee Break & Poster Session**

Chairs: João F. Mano & João Borges (University of Aveiro, Portugal)

11:15 - 12:00	**PL14. Jeroen Leijten** (University of Twente, the Netherlands) Advanced micromaterials and modular bio-inks for multiscale tissue engineering
12:00 - 12:30	**Closing Ceremony, Best Oral and Poster Awards & End of the Scientific Program** **João F. Mano & João Borges** (University of Aveiro, Portugal)
12:30 - 14:30	**Lunch Break**
15:00 - 19:00	**Social Program**

INVITED SPEAKERS

SHORT BIOS | ABSTRACTS

LIST OF PRESENTATIONS

Olli Ikkala

Aalto University

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Prof. Olli Ikkala is a distinguished professor of Aalto University/ Department of Applied Physics. His research interest is to develop functional materials based on hierarchical self-assemblies, biomimetics, and materials originating from nature. Originally educated in quantum physics, he was first affiliated 10 years in chemical industry to develop electrically conducting polymers. Professor Olli Ikkala has + 300 articles cited ca. 25,000 times, many in the most prestigious journals. He has been awarded twice both the Advanced Grant of ERC and the Academy Professorship of Academy of Finland. The awards include Alexander von Humboldt Research Award and Finnish Science Award. His recent interest is related to life-inspired dynamic materials, for example chemical programming for learning-inspired functions and homeostasis. He works in several advisory and evaluation duties nationally and internationally and has collaborated over the years with polymer, paint, and forest product industry.

ABSTRACT

Towards life-inspired soft matter dynamics and functionalities

Aalto University, Department of Applied Physics, P.O. Box 15100, FI-00076 Aalto, Finland

Soft matter properties have extensively been promoted by stimulus-responsiveness, shape-memory effects, and bio-inspiration towards ever more multifunctional properties [1-3]. Beyond the equilibrium and kinetically trapped static states, adaptive and dynamic dissipative feedback-controlled properties inspired by living matter would be among the next attractive functionalities, however, involving complexity [4-7]. Herein, we describe soft matter approaches inspired by selected functions of living systems. Classical (Pavlovian) conditioning, habituation, and sensitization are among the simplest "learning" concepts in behaviour [8]. Artificial Pavlovian conditioning has, not surprisingly, already been described in biosynthetic articifial systems [9]. We consider light and magnetic field as feasible stimuli because they can applied remotely. We show concepts algorithmically inspired by Pavlovian conditioning in common manmade soft matter systems [10-11]. We further show electrical conduction bistability, response plasticity, and adaptation based on soft ferromagnetic particle assemblies using magnetic stimulus, inspired by sensitization [12]. Finally, we show dynamic light-driven systems to allow feedback-controlled homeostasis and dissipative signal transduction [13]. Life-inspired soft materials can provide the next generation of out-of-equilibrium dissipative platforms for embedded materials intelligence and physical intelligence [14,15].

Acknowledgments: ERC, Academy of Finland

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Tanja Weil

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Prof. Dr. Tanja Weil has been Director at the Max Planck Institute for Polymer Research (MPIP) since 2017 and Managing Director since 2022. She studied chemistry (1993-1998) at the TU Braunschweig (Germany) and the University of Bordeaux I (France) and received her PhD from MPIP in 2002 under Prof. Klaus Müllen. From 2002 to 2008, she held various leading positions at Merz Pharmaceuticals GmbH, Frankfurt, Germany. In 2008, she accepted a position as Associate Professor at the National University of Singapore. Since 2010, Tanja Weil has been Director of the Institute of Organic Chemistry III at the University of Ulm. She has received competitive grants and awards at the national and international level, including the Otto Hahn Medal of the Max Planck Society, an ERC Synergy Grant, the Science Award of the City of Ulm, the Netherlands Supramolecular Chemistry Scholar Award and the Laureate Dr. Manfred Jäger Symposium, Heinrich Heine University Düsseldorf. She is a member of the Senate of the German Research Foundation as well as of the Leibniz Association and serves as Associate Editor for JACS. Her scientific interests are in the field of (bio)materials research and material-cell interactions.

ABSTRACT

Supramolecular Chemistry in Living Systems

Max Planck Institute for Polymer Research, Mainz, Germany

I will present the controlled synthesis of peptide nanostructures through cascade reactions that occur inside the living cell. The reactions take place in different cellular compartments, so that isomerisation and oxidation reactions can be controlled by cellular stimuli [1,2] or by light as an external stimulus [3]. The resulting nanostructures influence vital cellular processes depending on where they are formed [2]. To optimise the sequence of self-assembling peptides, computational approaches such as machine learning provide a powerful tool to identify completely novel sequences and elucidate their unique bioactivity and diverse interactions with cells [4].

Our ultimate goal is to synthesise functional peptide biomaterials that exhibit many of the properties of living matter, so that they can integrate and communicate with living systems to provide new ways to address medical challenges.

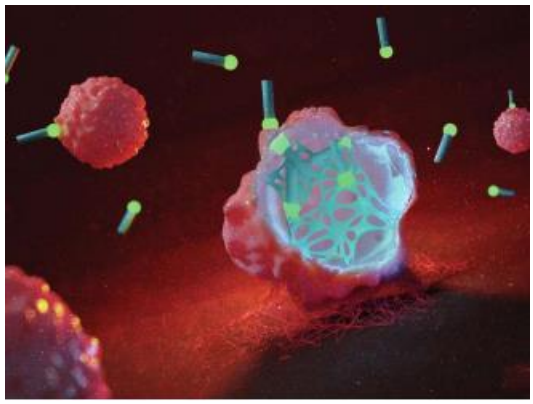

Figure 1. Bioresponsive isopeptide monomers enter living cells and undergo chemical transformations initiated by cellular or external stimuli. Supramolecular peptide nanofibers are formed inside cells that affect cellular processes.

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Maartie Bastings

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Maartje Bastings is a Dutch materials engineer who specializes in the synthesis of DNA-based supramolecular materials using multivalency as driving force in molecular design and functional performance. She demonstrated multivalent pattern recognition (MPR) as novel concept in multivalent binding, where interactions only take place when ligand and receptors are presented in rigid geometries with limited spatial tolerance. Her goal is to implement MPR as fundamental concept in the assembly of dynamic surfaces, control mechanical properties in soft matter, and explore the extent of conserved patterns in cellular signaling processes. Over the last 10 years, prof. Bastings has emerged as a specialist in bridging supramolecular materials with cell biology, always taking an engineering approach with a focus on biophysical quantification of interactions. Crossing supramolecular materials engineering with biophysics and cell biology creates a research space with the potential to advance the impact of DNA-nanotechnology both as functional material and as bioengineering tool. Besides fundamental insights in interaction-engineering, these materials have the potential to truly become integrated with cellular action to function as precision diagnostics and therapeutics.

ABSTRACT

(Super-) selective biomaterials: a balancing act of rigidity and geometry at the nanoscale

Programmable Biomaterials Laboratory, Institute of Materials, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

Biomaterials have catalyzed a profound transformation of our lives over the last century. Following decades of scientific innovations, biomaterials have become smaller, yet their function increasingly complex. Where macroscopic materials interact with many cells at once, nanomaterials interact only with a fraction of the surface of a single cell. Consequently, where (specificity), when (selectivity), with how many (multivalency) and how strong (affinity) these interactions take place, becomes key in determining function. Engineering (super-) selective materials is particularly relevant to advance drug delivery, diagnostics and personalized medicine.

In the Programmable Biomaterials Laboratory (PBL), we are intrigued by the multivalency (strength in numbers) principle and wondered if the selectivity between materials and the bio-interface could be controlled via the engineering of tailored multivalent surfaces. We explored how structural rigidity vs flexibility and uniform control over nano-geometry interplay toward multivalent selectivity, using DNA as programmable engineering tool. These DNA-based supramolecular macromolecules self-organize into functional nanomaterials through natural base-pairing interactions, providing the advantage that all nanomaterials are exact molecular copies. This allows to explore a new parameter space toward the engineering of selectivity, compared to what is accessible for classic nanomaterials (e.g. polymers, lipids, composites, metals), where properties as size, shape, number of functional sites, and spacing of molecules are inherently an average of the ensemble.

In this talk, I will show that molecular flexibility at interfaces comes with a cost in selectivity and demonstrate that the selectivity of immune-modulating biomaterials can be controlled via mechanical and structural design. Excitingly, we achieved super-selective interactions when functional binding units were spatially and geometrically constrained, a new concept we defined as “Multivalent Pattern Recognition (MPR)”. I will show how geometric patterns play a central role in cellular communication and how materials can truly become cell-type selective when tailoring molecular patterns of interface molecules on DNA-based nanomaterials.

João Borges

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João Borges is a Senior Researcher at the Department of Chemistry and CICECO – Aveiro Institute of Materials at the University of Aveiro, Portugal. He graduated and received his PhD in Chemistry from the University of Porto in 2008 and 2013, respectively, and conducted postdoctoral research at the University of Minho between 2013 and 2016. His research focuses on the molecular design, synthesis and development of supramolecular biofunctional materials to interface with living systems. In particular, he has been developing soft multicomponent self-assembling biomaterials by combining polysaccharides, self-assembling peptides and nucleic acids, to be used as bioinstructive matrices to control cell functions and as platforms for controlled drug/therapeutics delivery. He is author of original research articles, review papers, editorial, essay, comment, and viewpoint articles published in high impact journals including Advanced Functional Materials, Advanced Materials, Nanoscale, Chemical Reviews, Nature Chemistry, Angewandte Chemie, Chemical Science, and Journal of the American Chemical Society and has edited one book on soft matter for biomedical applications. In 2019, he was distinguished by IUPAC as an outstanding early-career chemist, being featured in the Periodic Table of Younger Chemist

ABSTRACT

Self-assembling polymeric biomaterials: from molecular design to interactions with living systems

CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal

Nature provides us with an unprecedented source of fascinating supramolecular systems that are inherently responsible for supporting and orchestrating the biological processes that sustain life on Earth. Those include the molecular motor proteins, the cell membrane, the DNA double-helical structure or the native extracellular matrix of tissues and organs. Such complex and intrinsically dynamic supramolecular landscapes, which are formed via the supramolecular self-assembly of the fundamental building blocks of life, including saccharides, nucleobases, peptides, phospholipids, and their derivatives, have inspired the supramolecular design and development of self-assembled biofunctional materials to recreate the structural complexity, fibrous architecture and functional dynamic nature of living systems and, ultimately, pursue advanced regenerative therapies.

In this lecture emphasis will be given to the synergistic use of polysaccharides, nucleosides, peptides and/or proteins, and bottom-up approaches towards the supramolecular engineering of a library of soft self-assembling multicomponent biomaterials, underpinning emerging properties and multifunctionalities at the nanoscale, for a myriad of applications in the biomedical field. In particular, the rational design and development, and physicochemical, mechanical and biological characterization of chemically programmable and dynamic supramolecular polymeric hydrogels, hydrogel-based bioinks and layer-by-layer nanobiomaterials will be presented. Moreover, their potential to be used as platforms for controlled drug/therapeutics delivery and as bioinstructive matrices to elucidate cell-biomaterial interactions and stimulate cell-signalling pathways that are pivotal in tissue engineering and regenerative medicine strategies will be discussed.

Acknowledgments:

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Tuomas Knowles is Professor of Physical Chemistry and Biophysics at the Department of Chemistry and at the Cavendish Laboratory at the University of Cambridge, United Kingdom (UK), co-director of the Cambridge Centre for Misfolding Diseases and Fellow of St John's College, Cambridge. His group research focuses on the physicochemical properties and behaviour of biological molecules and soft materials, with a particular focus on understanding the molecular principles that govern protein behavior in health and disease, as well as in generating functional materials by controlling protein self-assembly. Tuomas received his PhD degree (2008) in Biophysics from the University of Cambridge (UK), respectively. He was a visiting scholar at Harvard University and Weston Visiting Professor at the Weizmann Institute of Science in Israel. Prof. Knowles has received a number of distinguished honours and awards, including an ERC Consolidator Grant (2020), Rita and John Cornforth Award from the RSC (2019), Corday-Morgan Prize from the Royal Society of Chemistry (RSC, 2017), Raymond and Beverly Sackler International Prize in Biophysics (2017), Young Investigator Award and Medal from the British Biophysical Society (2014), Young Scientist Prize in Biophysics from the International Union of Pure and Applied Physics (2014), and the Harrison-Meldola Memorial Prize from the RSC (2012).

ABSTRACT

Functional artificial materials through self-assembly of natural peptides and proteins

University of Cambridge, United Kingdom

Many of the high performance materials in nature are formed from proteins. There is increasing interest to use these building blocks for technological applications in materials science since they are biodegradable and can be processed under mild conditions in aqueous solvent. This talk outlines our efforts to tune protein self-assembly and couple it with micro and macro scale processing to generate materials for applications ranging from sustainable packaging to drug delivery.

Cecília Roque

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Cecília Roque is an Associate Professor with Habilitation in Bioengineering and head of the Biomolecular Engineering Lab at the School of Science and Technology, NOVA University of Lisbon. She is UCIBIO Director since February 2023. Cecilia holds a degree in Chemical Engineering (Major in Biotechnology) and a PhD in Biotechnology from Instituto Superior Técnico. Cecília has been a Visiting Scholar at the University of Cambridge and at the Catholic University of America, a Post-doctoral researcher at the Institute of Biotechnology (University of Cambridge) and at INESC-MN (Lisbon, Portugal), and a Visiting Professor at the University of Cambridge, University of Nantes, University of São Paulo, City University of New York and KTH Royal Institute of Technology in Stockholm. Her research focus on biomimetics merging chemistry, biotechnology and engineering, and her work has been merited with several national and international distinctions. She has been awarded Starting and Proof-of-concept grants from the European Research Council (2014, 2022).

ABSTRACT

Opportunities from peptide and protein self-assembly in non-conventional solvents

Associate Laboratory i4HB – Institute for Health and Bioeconomy, NOVA School of Science and Technology, Universidade NOVA de Lisboa, 2829-516 Caparica, Portugal

UCIBIO – Applied Molecular Biosciences Unit, Department of Chemistry, NOVA School of Science and Technology, Universidade NOVA de Lisboa, 2829-516 Caparica, Portugal

Supramolecular self-assembly provides the possibility to generate modular and tunable materials with self-powered stimuli-responsive properties. This field is attracting enormous interest as an approach to functional materials design, and has tremendous, mostly untapped opportunities in creating new types of sensors. We have recently developed the concept of hybrid gels in artificial olfaction [1]. These materials result from the co-assembly of functional components – liquid crystals for reporting, ionic liquid as solvent, biopolymer as matrix - which give rise to molecular recognition properties towards volatile organic compounds (VOCs) not seen in the individual components. When casting the hybrid gels as thin films, they exhibited dual optical and electrical stimuli-responsive properties in the presence of VOCs. Films of hybrid gels are studied as gas sensing materials in a custom-built electronic nose, supported by a dedicated automatic classifier based on support vector machines for data processing [2]. It is also possible to employ deep convolutional neural networks (CNN) as pattern recognition systems to analyse optical textures in liquid crystal-droplets exposed to a set of different VOCs [4]. Furthermore, we show that the developed device can be used in dry and humid conditions, for the quantification of ethanol in automotive fuel or in fish spoilage monitoring [3,5].

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Colin Bonduelle is a CNRS researcher working at the Laboratoire de Chimie des Polymères Organiques (LCPO) at the University of Bordeaux. He is a biochemist by training and did his PhD thesis in polymer chemistry to become an expert in ring-opening polymerization. He currently works on the synthesis, characterization and application of protein-like polymers towards macromolecular therapeutics, nanomaterials/nanocomposites and bioactive scaffolds. His in-depth expertise in N-carboxyanhydride chemistry as well as the new tools he developed recently in their specific polymerization are an excellent platform to conceive the polymers for tomorrow's application following bioinspired and biomimectic design. This recently included ring-expansion methodologies to mimick antimicrobial peptides or aqueous ring-opening polymerization induced self-assembly processes (ROPISA).

ABSTRACT

Polypeptides: from proteins to new approaches in polymer synthesis

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Proteins are natural building blocks that have many features still unrivaled by their synthetic counterparts, including chemical diversity, hierarchical structure, specific chemical modification, programmed system dynamics, etc. Combined with their possible metabolism in living systems (biodegradation, etc.), these properties make proteins very interesting for designing the polymers of tomorrow. While significant advances in genetic engineering have been achieved, a major remaining challenge is to optimize proteins large-scale production (extraction, recombinant protein, etc.). Interestingly, the most economical and efficient route to polypeptides is a chemical methodology: the ring-opening polymerization (ROP) of amino acid N-carboxyanhydride (NCA) monomers (figure 1) [1]. Compared to proteins, peptidic polymers are much simpler macromolecules in which amino acids are statistically repeated. However, those polypeptides combine advantageous features of synthetic polymers (solubility, process, rubber elasticity, etc.) with those of natural proteins (secondary structure, functionality, biocompatibility, etc.) [2]. Recent progresses in this field have been impressive and this talk will illustrate 1) how the combination of coordination chemistry or DNA binding to polypeptide can be used to prepare smart polymeric systems [3], 2) how aqueous ROP of NCA monomers can be extended to a PISA process [4], and 3) how polymerization of NCA can afford simplified analogues of thermoresponsive tandem repeat proteins [5].

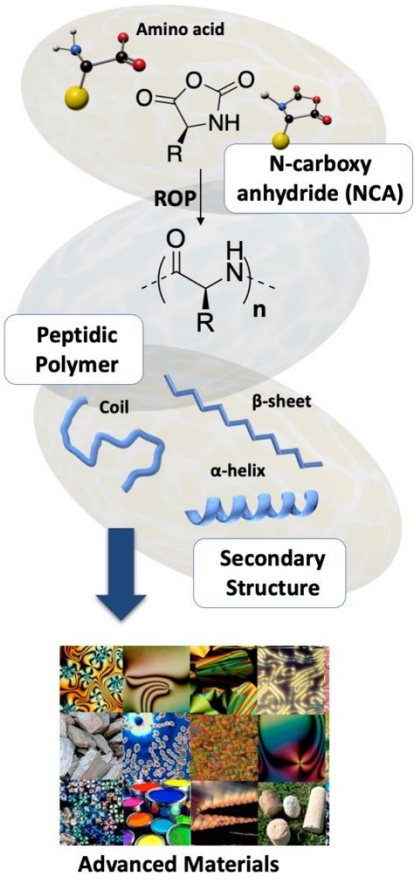

Figure 1. Peptidic polymers are ideal analogues of proteins to design advanced materials.

Acknowledgments: C. Grazon, E. Garanger, M. Nguyen, P. Verhaeghe, G. Manai, P. Salas-Ambrosio, A. Tronnet, S. Antoine, S. Jin, B. Dupuy, S. Tricard, M. Badreldin, R. Le Scouarnec, S. Harrisson and S. Lecommandoux, are sincerely acknowledged for their invaluable contribution to my overall work.

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Silvia Marchesan leads the Superstructures Labs (www.marchesanlab.com) at the University of Trieste (Italy) that she opened thanks to a starting grant in late 2015. Her research lies at the interface between nanotechnology and supramolecular chemistry to develop innovative bioinspired biomaterials. She is member of many Advisory Boards of international journals, such as Chem, J. Mater. Chem. B, ChemComm, Chem. Eur. J., Soft Matter, ACS Appl. Bio Mater., and RSC Mater. Adv. She is Fellow member of RSC (UK), member of ACS and MRS (USA) and SCI (Italy). She is member of several scientific committees, such as the Italian Peptide Society and the RSC Chemical Biology & Biological Chemistry Group (UK). She received various awards, such as the RSC Soft Matter Lectureship (2021) and the Erspamer Award (2017), and delivered international named lectures. She was selected by Nature as Rising Star in the natural sciences (2018) and by Nature Chemistry amongst those PIs shaping the future of the discipline (2019). Her multidisciplinary expertise is the result of research training in UK (PhD at The University of Edinburgh and research at UCL and University of Cambridge), Finland (University of Helsinki), Australia (CSIRO and Monash University), and Italy (University of Trieste and INSTM).

ABSTRACT

Chirality as a stargate in peptide-based biomaterials

University of Trieste, Italy

Homochirality is widely used by Nature in biopolymers (e.g., D-carbohydrates, L-proteins, etc.), and we explore new avenues in biomaterials by using heterochirality in minimalistic peptide sequences, composed of just a few amino acids [1]. This lecture will provide an overview of their design principles for bioactive soft matter, from the importance of the amino acidic sequence length to the effects due to the presence of non-canonical D-amino acids, which can boost and prolong bioactivity.

A milestone in our journey was the elucidation of how chirality affects spatial conformation for assembly from the molecular, nano-, micro- and all the way through to the macro-scale, to link the macroscopic properties of the final materials back to structural details of the building blocks [1]. As an example, replacement of intermolecular with intramolecular interactions was applied to direct self-organization towards cytocompatible and uniformly sized nanotubes, and to impede the uncontrolled formation of hierarchical heterogeneous structures [2]. Furthermore, heterochirality can be used to resolve the inherent tension of conflicting supramolecular instructions provided by the amino acidic components, so that assembly is directed towards different outcomes, such as macroscopic materials, or discrete nanostructures of differing morphology [3]. Other important parameters that direct self-assembly are the pKas of ionizable groups [4], and the conformational landscape visited by the building blocks in solution that drives assembly in different directions, towards crystals or gels [5].

Applications are vast, especially in the mimicry of enzymes or of the extracellular matrix, thanks not only to bioactive motifs, but also to morphological effects in guiding cell activity. Other types of bioactivities can be exploited to develop antimicrobials or new means of therapy for instance to inhibit amyloid fibrillation or stabilize protein biotherapeutics. New directions currently being explored include the use of these building blocks to attain life-programmable out-of-equilibrium soft matter.

Figure 1. Heterochiral peptide assembly as a stargate to the pillars of creation.

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Arri Priimägi is a professor of chemistry in the Faculty of Engineering and Natural Sciences at Tampere University, and the leader of Smart Photonic Materials research group. The group's focal areas of research revolve around different aspects of photocontrollable functional systems, ranging from synthesis of molecular photoswitches to applications of light-responsive materials in photonics, biomaterials sciences, and soft robotics. He obtained his Ph.D. in 2009 from Helsinki University of Technology (now Aalto University), followed by postdoctoral fellowships at Tokyo Institute of Technology and Politecnico di Milano. He presently holds an ERC Consolidator Grant "Multifunctional, Sensory-Motorized Material Systems", with the aim of learning from living systems to develop remotely driven shape-changing soft materials.

ABSTRACT

Light-driven soft actuators: multifunctionality and “life-like” characteristics

Smart Photonic Materials, Faculty of Engineering and Natural Sciences, Tampere University, Finland

Biological systems, viewed within the materials science perspective, are excessively complex. They are adaptive, multifunctional and -responsive, dissipative, self-regulating, and capable of evolving and learning from their past experiences. Hence, biological systems have provided a great source of inspiration for scientists aiming to design functional and “intelligent“ materials. Liquid crystal network- (LCN) and hydrogel-based soft actuators provide a rich platform for simplistically mimicking some of the properties of natural systems, as demonstrated by recent examples of systems that are deemed autonomous, adaptive, or self-regulating, i.e., “life-like” in a simplified sense. Yet again, all these systems fall way short on their natural counterparts in terms of complexity, capability to respond to environmental cues, and to evolve based on past experiences. Having this in mind, is such terminology justified? Is it useful for driving the field forward? The aim of this talk is to reflect on this question, using our own work on light-responsive soft actuating systems as an example.

Acknowledgments: Apart from all the group members who did the actual work, and collaborators who provided the actual ideas, special thanks to the European Research Council (Consolidator Grant MULTIMODAL, project number 101045223) and Academy of Finland (Centre of Excellence project LIBER, project number 346107) for trusting in us by funding our research.

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Nathalie Katsonis is Professor of Chemistry at the Stratingh Institute of Chemistry of the University of Groningen (the Netherlands), leading a research group dedicated to the design and creation of active molecular systems and materials that are inspired by the supramolecular, functional and stimuli-responsive systems found in nature, with a special focus on chirality, liquid crystals and artificial molecular machines. Nathalie received her MSc (2001) and PhD (2004) degrees from the University Pierre et Marie Curie (Paris, France), and did postdoctoral research in the group of Ben Feringa to investigate chirality and order in supramolecular assemblies. Her independent career started in 2007 as Associate Researcher for the CNRS, and in 2011 she took up a tenure-track position at the MESA+ Institute for Nanotechnology at the University of Twente (the Netherlands), where she was promoted to Professor in 'Bio-inspired and Smart Materials' in 2017. She is the recipient of several honours and awards, including an ERC Starting Grant (2012), an ERC Consolidator Grant (2017), Athena Award of the Dutch Science Foundation (2016), Gold Medal of the Royal Dutch Society of Chemistry (2017), Board of the van't Hoff Foundation (2018), Chair of the Board of the Stratingh Institute for Chemistry (2022), and Professor Werdelmann Lectureship of the University of Duisburg-Essen (2022).

ABSTRACT

Life-like morphological transitions in active droplets and protocells

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Morphogenesis is the biological process that causes a cell, tissue, or organism to develop its shape, and is performed through the concerted efforts of a complex protein machinery. Although the morphological changes of cells and microorganisms are integral to their function and development, building artificial microscopic systems that provide an experimental platform to study these processes has proved challenging. Here, we show that morphological transitions can be achieved in a wholly synthetic system of active droplets, by using artificial molecular switches to induce interfacial tension effects. In this system, we show that elongated, dendritic protrusions of fixed diameter are formed, their number and geometry being defined by the diameter and chirality of the droplet. Controlling shape transitions in synthetic systems by harnessing interfacial tension effects could lead to strategies that mimic complex and ultimately life-like tasks such as surface interactions between cells, cell adhesion to substrates, or migration.

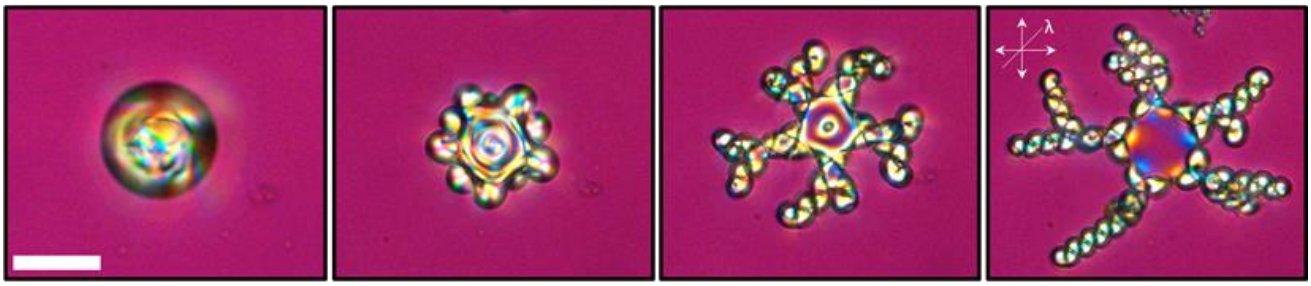

Figure 1. Polarized optical microscopy images evidence that chiral droplets undergo life-like morphological transitions in response to a light-induced drop of interfacial tension, promoted by amphiphilic molecular switches. The scale bar corresponds to 20 μm.

Acknowledgments:

We acknowledge support from the Dutch Research Council (ECHO program, 712.017.003) and the Dutch Ministry of Education, Culture and Science (Gravity program, 024.001.035). N.K. thanks the European Research Council for funding (Consolidator Grant Morpheus, 772564).

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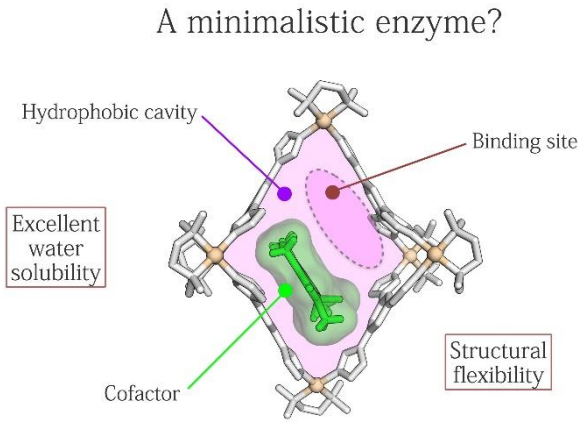
Rafal Klajn completed his undergraduate education and an MSc in Chemistry at the University of Warsaw in 2004. In 2009, he obtained a PhD degree at Northwestern University, where he worked with Profs. Bartosz Gzybowski and Sir Fraser Stoddart. After a roadtrip through the Rocky Mountains, he joined the Weizmann Institute of Science as a tenure-track assistant professor later that year. He was promoted to associate and full professor in 2016 and 2021, respectively. In August 2023, he moved his research group to Institute of Science and Technology Austria (ISTA). Klajn has served on the boards of several journals, including Chem, ACS Nano, and ChemSystemsChem, and received several awards, including the Netherlands Scholar Award for Supramolecular Chemistry, the Cram Lehn Pedersen Prize in Supramolecular Chemistry, and the Sigma-Aldrich lectureship in Materials Science.

ABSTRACT

Photochemistry inside a flexible coordination cage

Institute of Science and Technology Austria (ISTA)

Disequilibration by sensitization under confinement (DESC) is a supramolecular approach to isomerize photoswitchable molecules from the stable state to the metastable state using visible light of the desired wavelength (including red light). In this talk, I will show that a combination a coordination cage and a visible-light sensitizer can act together to selectively bind and sensitize the E isomer of various azobenzenes and other azo switches [1]. Upon switching to the metastable Z isomer, the azobenzene loses its affinity to—and is expelled from—the cage which can then convert additional copies of E into Z. In this way, the cage·sensitizer complex acts as a light-driven supramolecular machine converting light energy into chemical energy in the form of out-of-equilibrium photostationary states that cannot be accessed directly using visible light.



Acknowledgments: This work was done in collaboration with the groups of Igor Schapiro (Hebrew University of Jerusalem), Arri Priimagi (Tampere University), Matt Fuchter (Imperial College London), and Dan Oron (Weizmann Institute of Science). We acknowledge financial support from the European Union's Horizon 2020 Research and Innovation Program and the Academy of Finland.

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Jan van Hest obtained his PhD from Eindhoven University of Technology in 1996 in macro-organic chemistry with prof E.W. Meijer. He worked as a postdoc with prof D.A. Tirrell on protein engineering. In 1997 he joined the chemical company DSM in the Netherlands. In 2000 he was appointed full professor in Bio-organic chemistry at Radboud University Nijmegen. As of September 2016, he holds the chair of Bio-organic Chemistry at Eindhoven University of Technology. Since May 2017 he is the scientific director of the Institute for Complex Molecular Systems (ICMS). The group's focus is to develop well-defined compartments for nanomedicine and artificial cell research. Using a combination of techniques from polymer science to protein engineering, well-defined carriers are developed for application in e.g. cancer treatment and immunology.

Van Hest is one of the main applicants of two 10-year gravitation programs on Functional Molecular Systems (2012) and Interactive Polymer Materials (Eindhoven, 2022). In 2016 he was awarded an ERC Advanced grant. Van Hest is associate editor of Bioconjugate Chemistry. He has been elected member of the Academy of the Royal Netherlands Academy of Arts and Sciences (2019), and was awarded the Spinoza premium (2020), the highest scientific distinction in the Netherlands.

ABSTRACT

Polymer-based artificial cells

Eindhoven University of Technology, Institute for Complex Molecular Systems

Compartmentalization is generally regarded as one of the key prerequisites for life. To better understand its role, there is a clear need for model systems in which life-like properties can be installed. In this lecture I will discuss a synthetic cell platform composed of a complex polymer coacervate formed from oppositely charged amylose derivatives and stabilized by a semi-permeable polymer membrane. The coacervate structure resembles better the crowded environment observed in the cytoplasm than vesicular structures normally do. Cargo, such as enzymes, can be highly effectively loaded in the coacervates, based on complementary charge and affinity. This allows protocell communication with this robust synthetic platform. Via this system we have been able to show that we can bring enzymes involved in cascade reactions closer to each other, facilitating the outcome of the process. Using natural scaffolding proteins we can controllably take up and release proteins from the artificial environment, which mimics natural secretion. We have reconstructed the cellular architecture of a eukaryotic cell by incorporating multiple artificial organelles and an artificial cytoskeleton in the interior. Finally, we are able to incorporate life-like features such as motility in these structures, making this class of artificial cells a very versatile platform to study and mimic biological processes.

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Brigitte Städler is Professor at the Interdisciplinary Nanoscience Center at Aarhus University, Denmark. Prior to this, she obtained her PhD from ETH Zurich, Switzerland followed by post doc time at the University of Melbourne, Australia and an Assistant and Associate Professor positions at Aarhus University. Currently, she is the head of the 'Laboratory for Cell Mimicry', an interdisciplinary group working in the area of bottom-up synthetic biology focusing on nature inspired solutions to address medical challenges. Her research efforts combine organic and polymer chemistry with colloidal science and cell biology to assemble life-like units that can interact and support mammalian cells and tissues. Highlights include the reports on i) intracellularly active nanoreactors, ii) the integration of microreactors/artificial cells with mammalian cells and cell aggregates, and iii) directional self-propelled nanobots. Brigitte has over 110 peer-reviewed publications (google scholar h-index 43) and 5 book chapters. She obtained multiple fellowships including the L'Oreal/UNESCO - For Women in Science Fellowship, Denmark, the Carlsberg Foundation – Distinguished Associate Professor Fellowship, and an ERC Consolidator Grant.

ABSTRACT

Artificial cells and their interaction with mammalian cells

Interdisciplinary Nanoscience Center (iNANO), Aarhus University, Aarhus, Denmark

Bottom-up synthetic biology aims to design life-like units (aka artificial cells) that can substitute for missing/lost cellular activity or to add non-native function to mammalian cells and tissue. Artificial cells are minimal, simplistic structures that imitate selected structural or functional aspects of living cells.

We focus our efforts on hydrogel-based artificial cells equipped with a specific liver-like function and their integration with mammalian cells. In particular, these artificial cells support their living counterpart in fighting reactive oxygen species [2] and enhancing the CYP450 activity [1]. In the latter case, HepG2 cell aggregates were 3D bioprinted together with artificial cells with CYP1A2-like activity [3]. The resulting semi-synthetic tissue showed boosted conversion of catalytic activity due to the presence of the artificial cells for at least 2 weeks. In addition, we illustrated that artificial cells can eavesdrop on a typical activity of a liver cell due to co-existence in a semi-synthetic tissue [4].

Our efforts illustrate the potential artificial cells for tissue engineering purposes.

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Jeroen Leijten is an Associate Professor at the University of Twente, the Netherlands. He earned his MSc in Biomedical Sciences at Leiden University in 2007, and his PhD in Tissue Engineering with Prof. Blitterswijk at the University of Twente in 2012, where he continued to work as a postdoc for an additional year with Prof. Karperien. Then, he conducted postdoctoral research work in KU Leuven (Belgium) and Harvard-MIT (USA), before accepting a tenure track position at the University of Twente. His lab focuses on developing novel microtechnologies with a particular interest in microfluidics, micromaterials, and on-demand tunable biomaterials, which he leverages to create 3D spatiotemporal microenvironments to control (stem) cell behavior. Prof. Leijten is author of numerous papers in high-ranked journals including Cell Stem Cell, Nature Communications, Small, Advanced Functional Materials, and PNAS. He received numerous recognitions, including an ERC Starting Grant, and the Veni and Vidi awards from the Dutch Research Council, as well as multiple early-career and presentation awards/honors. Those include the Jean Leray Award by the European Society for Biomaterials (2020), the Robert Brown Early Career Principal Investigator Award by TERMIS-EU (2020), the 'Best engineering idea of 2018' by the Dutch Academy of Engineers and was twice selected as a 'top 10 North European Young Scientific Talent' (2017, 2018) by the popular science magazine New Scientist.

ABSTRACT

Advanced micromaterials and modular bio-inks for multiscale tissue engineering

University of Twente, The Netherlands

The modular design of tissues is of indispensable importance for proper organ function. For example, extracellular matrix is naturally produced in a modular way. Cells are entrapped in a thin layer of pericellular matrix, which in turn is located in a bulk of extracellular matrix. These two matrices are highly distinct in their biochemical and biophysical properties; while the pericellular matrix interacts with the cells, the extracellular matrix gives rise to organ level characteristics. Incorporating such a modular design into biomaterials is expected to allow engineered tissues to more accurately emulate the behavior of native tissues. However, recreating pericellular matrix has remained a grand challenge as it requires the coating of individual single cells in a micrometer thin layer of biomaterial. To overcome this challenge, I have developed microfluidic droplet generation platforms for the production of enzymatically crosslinked single cell microgels that were mere micrometers larger than the single cell they encapsulated. Using this platform, I engineered 3D single stem cell microniches with on-demand tunable biophysical and biochemical properties to controllably program stem cell differentiation along chosen lineages. For example, the microgels' Young's modulus can be accurately and on-demand tuned from 2 to 50 kPa. Single cell analysis revealed that softer microgels stimulated adipogenesis, while stiffer microgels induced osteogenesis. Temporally stiffening the microgels revealed that the first three days of differentiation where of key importance for stiffness-induced stem cell fate decisions. We then used our microgels technology to create a variety of advanced bioinks for the creation of tissues with innovative properties, which includes microporous tissues containing high density capillary networks, self-oxygenating tissues, and hierarchically organized living tissues with multi-scale designs. This materials toolbox thus allowed for an unprecedented control over the design and behavior of engineered living matter. Lastly, I used our most recent microgel platforms to realize the mass production of autonomously self-assembling 3D cellular spheroids, cardioids, and organoids. In short, I here present several microfluidic microgel-based concepts that are focused on advancing the engineering of multiscale hierarchical living tissues.

Oral Communication

ABSTRACTS

Oral Communication- 10th – 11th March |
Auditorium Renato Araújo – Central and Rectorate Building

1 **A. Kononenko**
Evolution of multivalent DNA-based supramolecular assemblies

2 **V. Pal**
Harnessing the Potential of Supramolecular Peptide Nanomaterials to Fuel Anti-Tumor Immunity

3 **E. Equy**
Janus polymersomes: mimicking biological motility for drug delivery applications

4 **T. John**
Peptide Self-Assembly and Corona Formation at the Bio-Nano Interface

5 **Z. Ma**
Printable tough adhesives with triggerable supramolecular interactions and extreme mechanical enhancement

6 **V. Sousa**
Dynamic protein-based G-quadruplex-derived supramolecular hydrogels as stable bioinks for healthcare

7 **A. S. Pina**
Peptide-Induced Coacervation: A Path to Enhanced Catalysis and Protocell Mimicry

8 **H. Zhao**
Functionalized liposomes for intracellular ROS scavenging in steatotic hepatocytes

ABSTRACT 1

Evolution of multivalent DNA-based supramolecular assemblies

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Multivalency enables nanostructures to bind molecular targets with high avidity. Achieving precision multimerization of diverse ligands poses a significant challenge using traditional platforms (proteins, dendrimers, nanobeads etc.). However, leveraging DNA nanotechnology provides a versatile and programmable platform for the precise assembly of ligands, affording control over their geometry, spacing, and molecular composition [1].

In this work we explore a novel molecular modality for the development of antivirals that harnesses multiple cooperatively binding units that are displayed on a target-tuned scaffold. Binding units are evolved from a combinatorial library of DNA-based polymers in a high-throughput fashion. In order to increase a chemical diversity of the library (and thus - potential levels of binding affinity) chemically-modified nucleic acid analogues were utilized. We termed this molecular modality MEDUSA (**M**ultivalent **E**ngineered **D**NA-based **S**upramolecular **A**ssemblies).

Acknowledgments: Cem Tekin, Kelvin Lau, Christine Lavanchy,

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ABSTRACT 2

Harnessing the Potential of Supramolecular Peptide Nanomaterials to Fuel Anti-Tumor Immunity

#V. K. Pal [1], Y. Shi [2], C. Redondo-Gomez [1], M. J. Oliveira [1], H. S. Azevedo [1]*

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Dysregulated amino acid metabolism plays a critical role in supporting cancer development. As cancer cells rely on essential amino acids (e.g. arginine, Arg, R) for their rapid proliferation, the consequent depletion of these vital molecules in the tumor microenvironment (TME) has shown impaired anti-tumor immune responses [1]. To address this challenge, there is growing interest in metabolic modulation to enhance cancer immunotherapies. Our approach leverages peptide nanotechnology to release crucial amino acids *in situ* when exposed to proteolytic enzymes overexpressed in the TME [2], thus enhancing the efficacy of immunotherapies. To test this hypothesis, we are exploiting peptide amphiphiles (PAs), composed of an aliphatic chain at the N-terminus, a segment of alanine residues for secondary structure formation, and a charged domain containing an arginine at the C-terminus [3], referred to as $C_{16}Ala_6$-Arg_3 and $C_{16}Ala_6$-His_2-Arg. These PAs were synthesized through solid-phase peptide synthesis, and their identity and purity were confirmed using LC-MS and reverse-phase HPLC. Spectroscopic and microscopic analyses revealed the formation of fiber-like nanostructures with a positive surface charge attributed to the terminal arginine. Additionally, we quantified the sequential cleavage of arginine using LC-MS. The cytotoxicity of PAs against select cancer cell lines and macrophages is currently under investigation and will be presented in this communication. Preliminary experiments demonstrate the feasibility of controlled release of key amino acids in the TME, and future studies will explore the potential of these released amino acids to enhance the anti-tumor responses of immune cells.

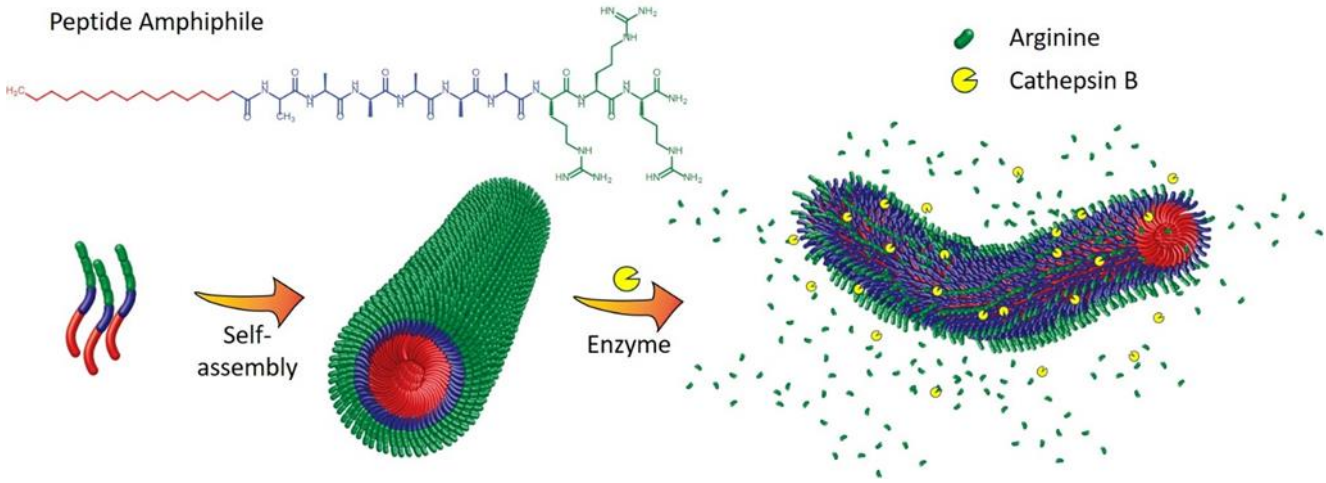

Figure 1. Enzymatic cleavage of terminal Arg from the surface of PA nanofibers by cathepsin B increases the availability of Arg at the tumor site for boosting an anti-tumor immune response.

Acknowledgments: This project has received funding from the EU's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 101108323.

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ABSTRACT 3

Janus polymersomes: mimicking biological motility for drug delivery applications

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Advanced structures and functions found in natural cells have inspired scientists to reconstitute life-like properties in artificial protocells [1]. Among many properties, achieving motility and directional swimming has great potential to develop smart therapeutics with drug delivery to targeted cells. In this context, a vast interest has been devoted in designing novel artificial microswimmers using different propulsion strategies [2]. One of the most efficient mechanisms is based on self-phoretic swimmers that propel themselves by generating a local gradient of concentration [3] or temperature [4], due to asymmetric properties. Our project aims at designing asymmetric Janus-like polymersomes able to propel themselves, either chemically powered by enzymatic decomposition of glucose or light driven by self-thermophoresis and functionalized with filamentous bacteriophages in order to improve their directional swimming efficiency. We will present the development of asymmetric Janus-like vesicles resulting from phase separation within the membrane between two block copolymers. We will show that copolymers can be rationally selected to self-assemble either by solvent free or solvent displacement methods into asymmetric polymersomes and that the phase separation can be tuned playing on different parameters such as the ratio, the molecular weight and the temperature.

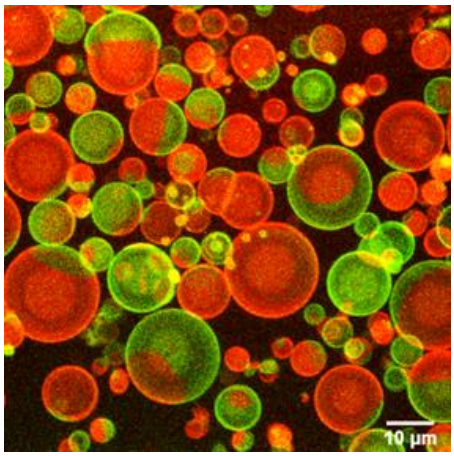

Figure 1. Janus polymersomes made of two different copolymers prepared by electroformation method.

Acknowledgments: Acknowledgment to the University of Bordeaux for funding this PhD. Project.

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ABSTRACT 4

Peptide Self-Assembly and Corona Formation at the Bio-Nano Interface

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Self-assembled peptide and protein structures play a crucial role in biological systems, with some fibril-forming peptides being implicated in neurodegenerative diseases while others have been observed in functional forms. The self-assembly of peptides into fibrillar structures is influenced by the physiochemical environment, including the presence of interfaces like cellular membranes and liposomes [1]. Liposomes, as nanostructures, possess diverse surface properties based on their biochemical composition. To better understand how surfaces impact peptide folding and self-assembly, a combination of experimental and computational studies was employed. Surfaces were chemically modified with functional groups to study the role of hydrophobicity and charge. Further studies were performed on the effects of membrane composition and nanoparticle curvature on peptide aggregation [2,3]. Molecular dynamics simulations supported the mechanistic understanding of the structure formation process within the peptide corona. A model that incorporates competition between peptide-surface attraction and intrinsic aggregation propensity has been developed. This research explores the role of nanoparticles in nanomedicine, highlighting how surface chemistry and curvature can either accelerate or inhibit peptide self-assembly. Beyond the biological context, peptide self-assembly is discussed for the engineering of functional structures.

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ABSTRACT 5

Printable tough adhesives with triggerable supramolecular interactions and extreme mechanical enhancement

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Bioadhesives can intimately connect human and machines, seamlessly bond diverse tissues in our human body, and manage various diseases [1]. However, the precise spatiotemporal control of wet and tough adhesion of biocompatible hydrogels on biological tissues remains a major challenge [2]. Inspired by the bioglue secreted by sandcastle worm, we propose the design of printable tough adhesive (PTAs), a supramolecular hydrogel that can be printed into defined structures, undergone triggered condensation and phase transition into tough matrix, and strongly adhered to diverse substrates, including tissues, hydrogels and medical devices. With carefully selected polymer molecular weight, charge density and ratio, we discovered that our 3d printed PTAs showed 2-order-of-magnitude increase in toughness, tensile strength and stiffness when immersed in water/saline solution or attached to biological tissues. To assess the robust toughening mechanism triggered by the supramolecular interactions, we thoroughly investigated the effects of polymer contents, pH, crosslinker on PTA mechanical performance. The promising broad applications of PTAs are further demonstrated for biofabricating musculoskeletal tissue mimetics, controlling patterned bioadhesion, and designing programmable soft robotics. In conclusion, by leveraging bioinspired benignly triggerable supramolecular interactions, we design PTAs that can be printed with desired architectural and structural features, mechanically toughened after being applied on the application site, and robustly integrated with the native tissues, thus they are expected to find exciting applications in regenerative medicine.

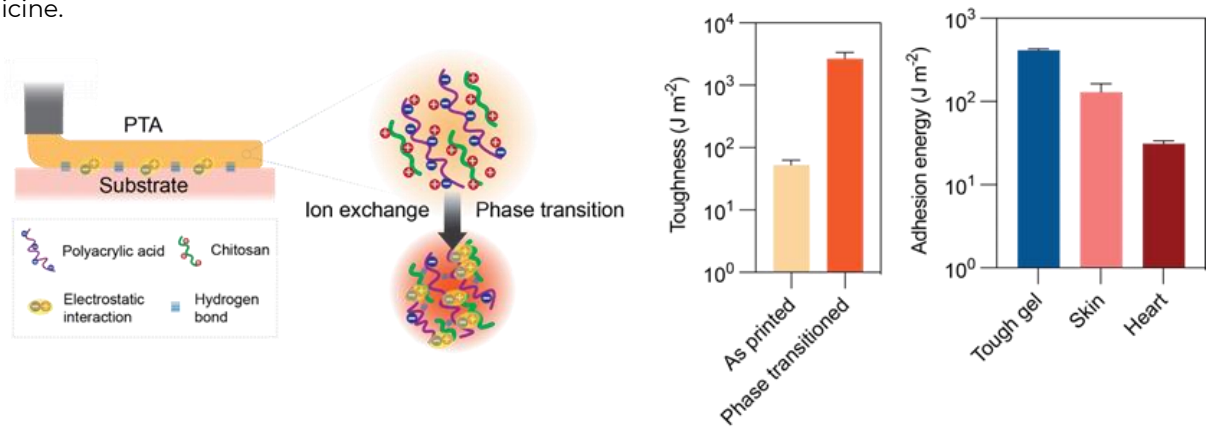

Figure 1. Design principles and mechanical performance of bioinspired printable tough adhesives (PTA).

Acknowledgments: We acknowledge the financial support from Fonds de Recherche du Québec Nature et technologies (FRQNT), Canadian Institutes of Health Research (CIHR) and Natural Sciences and Engineering Research Council of Canada (NSERC).

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ABSTRACT 6

Dynamic protein-based G-quadruplex-derived supramolecular hydrogels as stable bioinks for healthcare

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G-quadruplexes, unique four-stranded structures found in guanine-rich DNA and RNA sequences, have garnered significant attention due to their self-assembled nature and crucial participation in various biological processes, such as DNA replication, transcription, translation, and telomere maintenance [1-3]. In this study, a novel gelatin-based G-quadruplex-derived supramolecular bioink was successfully produced by self-assembling guanosine, 2-formylphenylboronic acid, and gelatin in the presence of potassium ions (K^+). The stability of the G-quadruplex supramolecular biomaterials was successfully accomplished by the synergistic effect of transglutaminase (TG)-mediated enzymatic crosslinking and macromolecular crowders (MMC), the latter reducing the activity of water molecules surrounding the G-quadruplex structures and enhancing their stability via dehydration. The dynamic bioinks were characterized for their chemical and rheological properties, printability, and in vitro biological performance. The overall results showcased that the G-quadruplex self-assembled structures mostly adopt a parallel secondary structure, characterized by a π-π stacking and an interhelical distance of 3.3 Å and 22.2 Å, respectively. Additionally, the MMC improved the bioink viscosity, yield stress, and shear-thinning behavior, thus enhancing the filament and shape fidelity. This bioink holds great promise for (bio)printing highly complex and multifunctional 3D structures that could better recreate damaged tissues and/or organs and be used in multiple tissue engineering and regenerative medicine strategies.

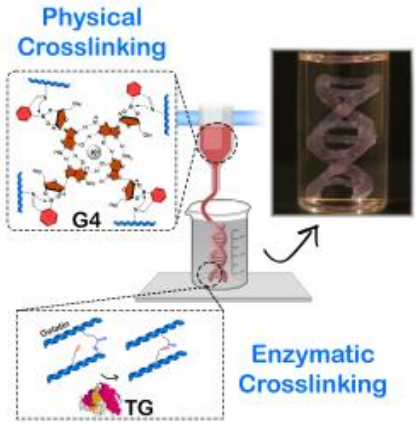

Figure 1. 3D bioprinting of stable gelatin-based G-quadruplex-derived supramolecular bioinks.

Acknowledgments: This work was funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE"). This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MEC (PIDDAC). The financial support by FCT through the PhD grant (2020.06771.BD, V.S.), Junior Researcher (2022.04605.CEECIND, R.S-A) and Assistant Researcher contracts (2020.00758.CEECIND, J.B.) is gratefully acknowledge.

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ABSTRACT 7

Peptide-Induced Coacervation: A Path to Enhanced Catalysis and Protocell Mimicry

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Liquid-liquid phase separation (LLPS) in living cells provides innovative pathways for synthetic compartmentalized catalytic systems. Studies show that certain amino acids in disordered proteins are crucial for LLPS and the formation of membraneless organelles. To better understand this, researchers have developed simple model systems using designed peptides that mimic these protein features [1-4]. However, the challenge of developing coacervates from simple building blocks that simultaneously govern condensate organization and mediate functionality remains largely unaddressed.

In our lab we are focusing at establishing fundamental knowledge on the sequence-disorder-phase transition propensity in peptides motifs from phase-separating proteins to control peptide organization and potentiate peptide chemical reactivity. We are exploring the potential use of phase-separating peptides as precursors of the origin of chemical reactivity and life, and as future protocell mimetics.

By using flexible (catalytic) peptide as model systems [5], we show the potential of a single peptide to induce reversible coacervate formation. Our findings show that the peptides undergo a transition from a flexible conformation to a coacervate-forming peptide with a structured domain. Remarkably, these coacervate-based microreactors exhibit a 15,000-fold increase in catalytic efficiency compared to soluble peptides and selectively sequester phosphotyrosine-containing substrates (Fig.1). LLPS emerges as a fundamental mechanism in the evolution of chemical functions, by effectively managing conformational flexibility and providing valuable insights into the evolution of enzyme activity and catalysis in prebiotic chemistry.

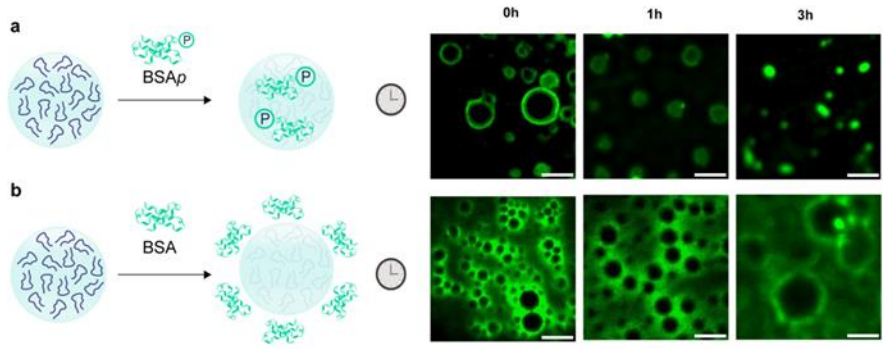

Figure 1. Affinity-mediated molecular uptake within a model peptide-based coacervates. Time-lapse microscopy captures of the uptake of phosphorylated assemblies inside coacervates. FITC-labeled BSAp and BSA were incubated with coacervates for 3h. Representative fluorescence confocal images highlight the molecular uptake within coacervates (a) for FITC-labeled BSAp and (b) the exclusion of BSA at the boundaries of coacervates. Scale bar set to 10µm.

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ABSTRACT 8

Functionalized liposomes for intracellular ROS scavenging in steatotic hepatocytes

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Metabolic dysfunction-associated steatotic liver disease (MASLD) represents a prominent contributor to worldwide liver-related morbidity and mortality [1]. It refers to the anomalous accumulation of fat droplets within hepatic cells, accompanied by various negative aspects including elevated levels of reactive oxygen species (ROS) [2]. In addition, acetaminophen (APAP), which is widely used for the management of pain and hyperthermia in clinical settings could further induce liver injury, because of toxic metabolic products via CYP450 in the liver [3]. Herein, we illustrate that tail-modified phospholipids can transport compounds to intracellular lipid droplets in steatotic hepatic cells, using the cell's inherent intracellular lipid transport mechanisms. We first identify a suitable cell model by challenging HepG2 cells with free fatty acids and APAP. Then, we conjugated an antioxidant, an EUK salen–manganese derivative [4], which has superoxide dismutase-like and catalase-like activity, to the tail of a phospholipid that was formulated as liposomes for administration. Steatotic HepG2 cells incubated with these antioxidant liposomes have lower intracellular ROS levels compared to untreated controls and non-covalently formulated antioxidants. Our feasibility data illustrated that engineered lipids can be used to equip native lipid droplets in mammalian cells with desired enzyme-like activity.

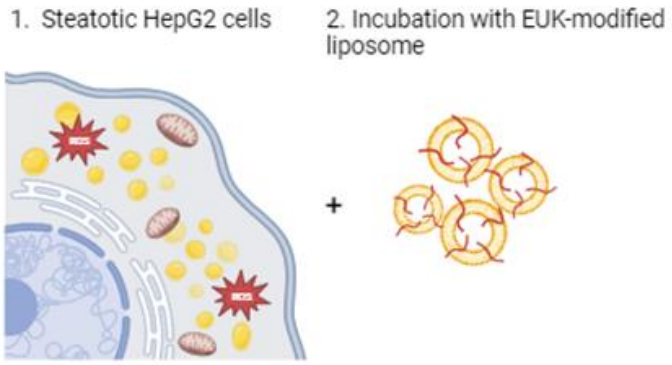

Figure 1. Schematic illustration. Steatotic HepG2 cells are incubated with EUK-modified liposome, which could escape from lysosome, to reduce intracellular ROS levels.

Acknowledgments: This project is supported by the Novonordisk Foundation.

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ABSTRACT 1

Talking to Cells: Cell induced matrix-stiffening by metabolic players

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Cancer is understood as a metabolic disease. The role of lactate in cancer was elucidated by Otto Warburg in 1927, asserting that cancer cells exhibit an increased uptake of glucose, resulting in elevated lactate production—a phenomenon known as the "Warburg effect." Lactate, identified as a significant signaling molecule in cancer progression, is released from cancer cells, contributing to the acidification of the tumor microenvironment (TME), with pH levels ranging from 6.3 to 6.9. This acidic environment favors various processes such as tumor promotion, angiogenesis, metastasis, tumor resistance, more importantly, immunosuppression [1]. In contrast, the extracellular matrix of most normal tissues under physiological, well-perfused conditions in vivo maintains a relatively stable pH range, mirroring blood pH at 7.3 to 7.4 [2-3].

These unique features create chances to use metabolic signals from cancer cells, manipulate the TME, and trigger responses from the cells [4]. This innovative approach facilitates controlled communication between cancer cells and their matrix, representing a "talking to cells" strategy at the dynamic interface of living systems and biomaterials.

To implement this, cells are cultured in catalyst-modified biopolymer hydrogels. Depletion of important metabolites leads to TME manipulation and triggers the stiffening of the functionalized matrix. This study focuses on both the material and cell properties and examines the influences of dynamic stiffening. Ultimately, this approach enables communication between mammalian cells and their matrix through the degradation of metabolic players.

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ABSTRACT 2

Transient bioactive self assembling peptides

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In nature, biological function of enzymes, membranes, or viruses is grounded in supramolecular self assembly. This phenomenon is ubiquitous and observable across various length scales. Inspired by this concept, supramolecular self assembly has gained increasing attention in peptide chemistry in the last decades. Due to their inherent versatility and straightforward synthesis, self assembling peptides are widely employed in biomedicine with great success [1]. Stimuli responsive systems reacting to endogenous or external triggers were implemented to increase spatial temporal control over peptide assemblies [2]. However, despite responsivity, the resulting nanostructures are often static due to kinetic trapping or the reaching of the thermodynamic equilibrium. To overcome this hurdle, researchers have developed transient peptide assemblies that form far from thermodynamic equilibrium (out of equilibrium systems) [3]. This phenomenon is prominently observable in processes such as microtubular self assembly where dynamic instability dictates biological function. In the lab, these energy states are often accessed through high-energy fuels such as carbodiimides [4]. We present here a combinational approach that may approximate natural systems through high energy peptide fuels. The reaction between activated peptides and thiol containing peptide derivatives gives rise to new chemical reaction networks that are potentially tuneable in their dissipation pathway kinetics.

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ABSTRACT 3

Bioconjugation of bioactive molecules to self-assembling peptides for neuron regeneration

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Damage to the central and peripheral nervous system (CNS and PNS) often results in cavity formation at the injury site. Neuron tissue engineering is a powerful tool to combine biomaterials, bioactive molecules, and neuronal cells to treat such cavities. Unlike the PNS, the CNS has a limited capacity to fully recover, due to local inhibitory factors, such as low neuronal population, directional synaptic connection, and irreversible scar formation. Building on our previous research, self-assembling peptides (SAPs) that promote PNS regeneration are studied in detail to elucidate correlations between their structure and bioactivity. In parallel, selected SAPs are conjugated with neurotrophic singaling molecules for in vitro screening using primary neurons. The best candidates are evaluated for their potential in treating injuries in an in vivo model. We anticipate building facile bioconjugation routes between SAPs and biomolecules that serve as scaffolds for CNS neuron regeneration.

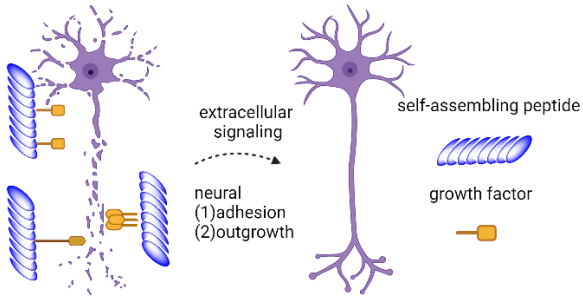

Figure 1. Conceptional scheme of self-assembling peptides as a synthetic extracellular matrix functionalized with neuroactive molecules for CNS regeneration

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ABSTRACT 4

Highly robust human-derived hydrogels for Tissue Engineering applications

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Hydrogels have been widely explored in the field of Tissue Engineering and Regenerative Medicine due to their unique features that include i) high water content - which provides an ideal environment for cell survival; ii) the ability to maintain a distinct and biocompatible 3D structure - providing mechanical support for encapsulated cells; and iii) the ability to simulate the native extracellular matrix. Despite these advantages, hydrogels softness makes them prone to mechanical failure and brittleness, limiting their use in applications that require high levels of mechanical stability [1]. In this sense tough double network (DN) hydrogels have been designed to address the mechanical limitations of soft hydrogels, making them less prone to failure under stress [2]. Still, the limited diffusion of nutrients through DN hydrogels may hinder cell survival and proliferation. Additionally, the lack of control over the degradation rate of these hydrogels can further affect nutrient diffusion and the viability of cells encapsulated [3]. In this sense, we propose the development of a human-derived DN hydrogel of methacryloyl platelet lysates (PLMA) and chitosan to yield a material with enhanced mechanical properties, but still, suitable for the cell survival of encapsulated cells. Human adipose-derived stem cells (hASCs) were seeded on top of the hydrogels showing very promising results along the first seven days once the vast majority of cells remained viable for all formulations. Also, owing the well described properties of PLMA we envision that this human-derived DN system may also promote cell proliferation and tissue formation within the hydrogel. We envision that this multimodal hydrogel could likely be used for the repair of load-bearing soft tissues or as an encapsulation platform for several biomedical applications, including disease modeling for the screening of new therapeutics in more mimetic environment.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC)." The authors would also acknowledge the doctoral grant 2022.13351.BD and the individual contract 2021.02196.CEECIND (A. Sofia Silva). This work was also funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE").

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ABSTRACT 5

Catechol analogs' many roles in the multifunctionality of liquid gelatine-based capsules

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Currently, bioengineering is looking for a simple strategy to build a reproducible and scalable structure, translatable to different applications. In this work, using gelatin modified with two different catechol analogs (Hydroxypyridinone-HOPO and/or Dopamine-DA) as building blocks in creating liquefied protein-based capsules, we provide a biocompatible and bioactive environment with self-healing structural properties [1 ,2].

The self-healing properties derived from the coordination of HOPO with iron provide the development of a new *in vitro* system capable of allowing the encapsulation of cells or the injection, at different times, of living and non-living microsystems without compromising the structure of the capsule. The rapid adhesion, organization, and proliferation of cells after injection or encapsulation are critical for creating hierarchical cell/structural co-culture systems that can bring us closer to understanding the complexity of tissues. The inclusion of DA in the capsule shell improves the system, due to its affinity for calcium ions, allowing the mineralization, and accelerating the cellular differentiation process without compromising the capsule structure over time. In the end, this scaffold offers a new concept of in *vitro* culture as semi-closed, customizable, and storable capsules that allow organizing and shaping cell culture hierarchically in time and space in a more efficient way.

Acknowledgments: The authors acknowledge the funding from the European Research Council (ERC) through the project “Reborn” (ERC-2019-ADG-883370). We acknowledge the financial support from the Portuguese Foundation for Science and Technology (FCT) through the projects: TETRISSUE (PDTC/BTM-MAT/3201/2020); and “CICECO-Aveiro Institute of Materials” (UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020), financed by national funds through the FCT/MEC (PIDDAC). This work was also funded by the European Union’s Horizon Europe research and innovation program under the grant agreement No. 101079482 (“SUPRALIFE”). Ana R. Pinho acknowledges FCT for the PhD grant (2021.05888.BD).

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ABSTRACT 6

Clickable Surface Functionalization of Hierarchical Supra-Cellular Assemblies

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So far, the fabrication of man-made living human tissues using bioengineering techniques has remained elusive. Current efforts in the tissue engineering field have been moving towards the fabrication and exploitation of living materials – i.e., cell-rich platforms in which cell-cell interactions govern the material behavior and evolvability [1]. These man-made living architectures aim to present tissue-relevant biofunctionalities and improved bioactivity, revealing tremendous potential for revolutionizing the fields of tissue engineering and disease modeling [1]. To fulfill the pursuit of generating increasingly complex living materials that better mimic native tissues, bioengineering approaches have been focused on exploring the modification of mammalian cell surfaces to attain control over cellular interactions and to promote the assembly of living materials in a unit-programmable manner [2,3]. To be a step closer to this goal, herein, metabolic glycoengineering approaches combined with biorthogonal click chemistry were explored to functionalize the surface of mammalian cell spheroids with multiple polymeric chains via strain-promoted azide-alkyne cycloaddition (SPAAC). Ultimately, these findings may open new avenues to improve the processability of these complex mammalian multicellular aggregates and modulate the interactions with the surrounding environment.

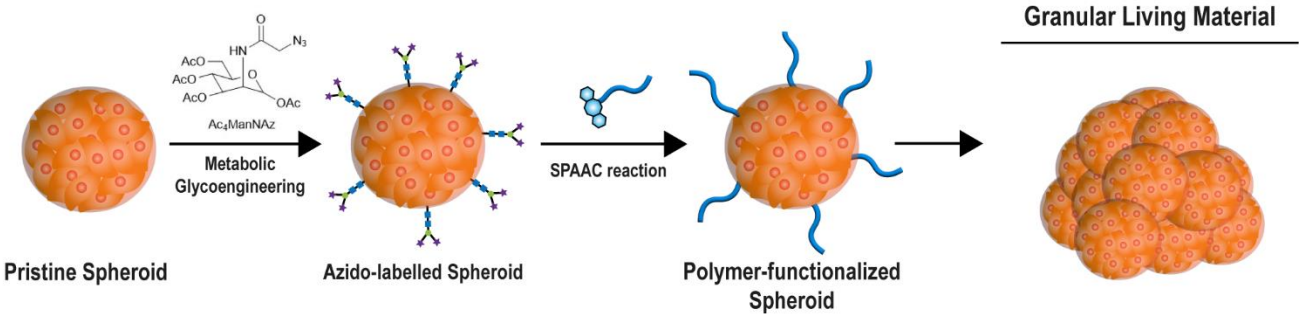

Figure 1. Schematics of dual-step surface modification strategy for engineering mammalian spheroids.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC). This work was also funded by the European Union's Horizon Europe research and innovation program under the scope of SUPRALIFE project (Grant agreement 101079482).

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ABSTRACT 7

Bioactive human-based bio-inspired scaffolds for bone tissue engineering

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Bone has the capacity to regenerate itself in many situations, however when the defect is caused by trauma, systemic diseases, pathological fractures (consequence of metastasis or primary malignancy), infection or a compromised blood supply, this ability to adequately self-heal can fail [1].

Currently, the treatments for bone defects comprise bone transplantation (including autografts, allografts, and xenografts) and implantation of synthetic bone substitutes (metal, polymeric implants, and so on). Nevertheless, these methods still have shortcomings as supply limitation, resorption of surrounding tissue, risk of donor site morbidity, infection, rejection, high rate of failure or loosening (lack of osseointegration). Moreover, when the defects are severe, the options are very limited [2]. Considering these issues, bone tissue engineering and regenerative medicine may offer added advantages in managing bone loss.

In this sense, in this project, we are developing scaffolds based on human-derived proteins from placenta chorionic membrane, highly abundant of numerous extracellular matrix proteins, as collagen and laminin as well as important growth factors [3]. We methacrylated the decellularized chorionic membrane obtaining photopolymerizable methacrylated chorionic membrane (CMMA), which may be used to produce hydrogels and cryogels. Moreover, we explored the CMMA to develop anisotropic structures with oriented porosity by unidirectional freezing, aiming to better mimic the anisotropic microstructure characteristic of the hierarchical bone tissues.

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ABSTRACT 8

Combining supramolecular and covalent crosslinks in the design of human-based bioinks

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Extrusion bioprinting offers tremendous potential in the fields of tissue engineering and regenerative medicine by facilitating the fabrication of functional tissue constructs with precise architectures and complex compositions. However, significant limitations exist in the design of biocompatible bioinks that combine good printability with the required biological relevance to produce biomimetic constructs. Natural polymers such as collagen and ECM-derived matrices have long been proven promising substrates for cell culture, as they provide an adequate environment for cells to adhere, migrate, and proliferate; yet, despite their natural ability to form hydrogels through physical crosslinking in response to temperature, this type of materials do not possess the necessary mechanical properties to be extruded while maintaining satisfactory shape fidelity of printed constructs. In this work, we propose the development of a human-based bioink combining a collagen-enriched fraction from decellularized placenta, to provide printability and mechanical support to cells, and a photocrosslinkable portion from methacryloyl platelet lysates (PLMA)[1], to stabilize the ink upon extrusion and supply bioactive molecules. The collagen-enriched fraction was obtained from decellularized human placentas after sequential salting-out of proteins (especially collagens) and the photocrosslinkable part through chemical modification of human platelet lysates with methacrylic anhydride. Results showed that the combination of these two materials improved the quality of extrusion-printed human-based bioinks while maintaining their inherent ability to support cell growth in vitro.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC). The authors would also like to acknowledge the support of the European Research Council Proof-of-Concept Grant Agreement No. ERC-2020-PoC-957585 for the project Amniogel and No. ERC-2022-PoC2-1010822210 for the project HumanINK. This work was also supported by the Foundation for Science and Technology through the individual contract 2020.01647.CEECIND of Dr. Catarina A. Custódio and the doctoral grant 2021.05271.BD of Inês A. Deus. The authors would also like to acknowledge the support from Metatissue®.

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ABSTRACT 9

All-aqueous freeform fabrication of fiber-shaped soft compartments with pore-like topographies for cell transmigration

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Strategies based on the encapsulation of cells and biomolecules in membrane-bounded capsules were firstly designed with the goal of protecting the biological cargo from the immune system for the treatment of endocrine diseases. Over the years, they have also been shown application in the tissue engineering and regeneration fields. These materials are usually spherical-shaped, but more recently, other geometries are being explored, including fiber-shaped tubular structures [1]. Several biofabrication techniques have been studied for the generation of tubular materials; however, they often require specialized equipment, or rely on time-consuming and multistep procedures, or even the use of toxic solvents.

Herein, a poly(ethylene glycol)/dextran prototypical aqueous two-phase system was used to support the generation of fibers with hollow features in a single step. The addition of oppositely charged polyelectrolytes in each phase, enabled their complexation at the interface, forming a stabilizing membrane. The produced materials with controllable length can be perfused and maintain the viability of encapsulated human mesenchymal stem cells, allowing their adhesion and spreading due to addition of cell adhesive moieties [2].

Material porosity is key not only to ensure adequate permeability and nutrient diffusion but also to promote the migration and invasion of cells. Here, we show the ability to induce pore-like topographical features in the interfacial membrane envisioning the transmigration of cells to the surrounding environment. This work presents a straightforward approach for the rapid generation of flexible compartments able to support the growth and migration of relevant human cells with regenerative properties.

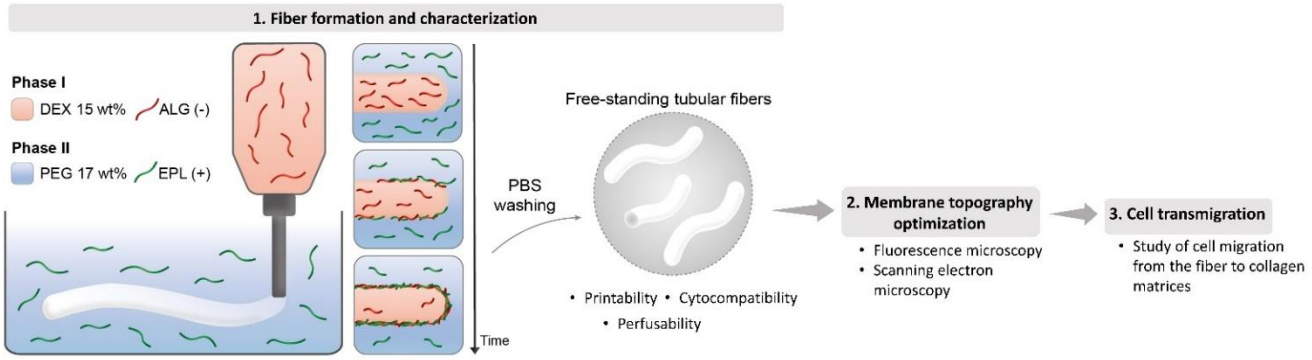

Figure 1. Graphical abstract.

Acknowledgments: This work was funded by the European Union's Horizon Europe research and innovation programme under the Grant Agreement No. 101079482 ("SUPRALIFE"). This work was financially supported by the European Research Council grant agreement ERC-2019-ADG-883370 (project REBORN). It was also developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC). Raquel C. Gonçalves also acknowledges financial support received from FCT trough individual grant 2021.07435.BD.

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ABSTRACT 10

Bioorthogonally Clickable Supra-Cellular Assemblies: Engineering a New Generation of Immune Living Materials

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This study integrates cell surface engineering and immune cell modification to create living building blocks while addressing the challenges of current immunotherapies, particularly systemic delivery. The focus involves using immune cells as platforms for covalent ligation with a bioorthogonal polymer through the Strain-Promoted Azide-Alkyne Cycloaddition (SPAAC) reaction. Advanced cell surface engineering chemistry is employed to modify immune cells, offering a unique means of tailoring cellular interactions and behaviors. The manipulation of glycans using metabolic glycoengineering (MGE), by introducing exogenous sugar analogs into cellular metabolic pathways, provides the foundation for covalent ligation, as the immune cells then take control of the system, forming autonomous living materials. The covalent ligation imparts controlled properties to the building blocks while facilitating cell-cell interactions. Such interplay between modified cells enables a collective, self-regulating behavior reminiscent of native biological systems. Emphasizing the precise click chemistry demonstration, the study delves into the chemical intricacies of immune cell modification, highlighting the interplay between MGE and SPAAC reactions. Insights from this work contribute to developing biofunctional living materials with potential applications in immunotherapy, offering innovative biomedical solutions by leveraging the autonomy and dynamic responsiveness of living materials.

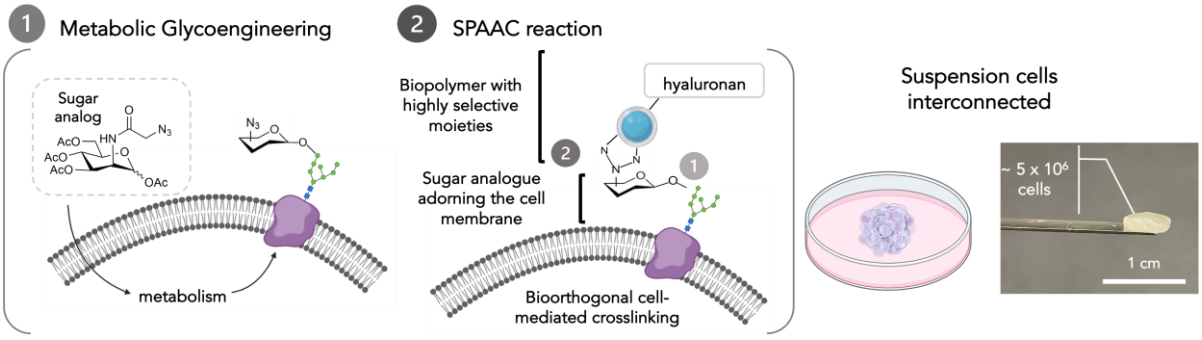

Figure 1. Schematics of the two-step assembly of immune cell-based living materials with high cell density via (1) metabolic glycoengineering and (2) SPAAC reaction.

Acknowledgments: This work was funded by the European Union's Horizon Europe research and innovation program under the Grant Agreement No. 101079482 ("SUPRALIFE"). The authors also acknowledge the funding from the European Research Council (ERC) through the project "Reborn" (ERC-2019-ADG-883370) and "CICECO-Aveiro Institute of Materials" (UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020), financed by national funds through the FCT/MEC (PIDDAC). Matilde Lagarto acknowledges the financial support by the University of Aveiro through an individual Doctoral Grant. Vítor Gaspar acknowledges FCT for an Assistant Researcher contract (CEECIN/02106/2022).

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ABSTRACT 11

Cell-loaded stimuli-responsive coacervate-based material for advanced biomedical applications

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In biomaterial applications, most polymeric systems typically remain in static conditions. To address this limitation, "smart" or "stimuli-responsive" polymers have gaining attention. Thermo-responsive polymers, known for their solubility changes in response to temperature variations, have been widely used. However, their conjugation with complex coacervates has been underdeveloped. Complex coacervation is characterized by a liquid-liquid phase separation phenomenon, that occurs in solutions containing oppositely-charged macromolecular species. In this work we present a novel thermo-responsive coacervate formed through the combination of two oppositely charged natural polyelectrolytes grafted with PNIPAAm (Poly(N-isopropylacrylamide), a well-known thermo-responsive polymer. The modification of PNIPAAm with terminal amino (-NH_2) and carboxylic acid (-COOH) groups was successfully achieved and confirmed by ^{1}H NMR. These modified PNIPAAM polymers were grafted onto Chitosan (CHT) and Hyaluronic acid (HA) using EDC/NHS coupling chemistry. The combination of CHT-g-PNIPAAm and HA-g-PNIPAAm, under specific conditions, yielded a coacervate with thermo-responsive properties. The coacervate assembly, thermo-responsive behavior, rheological features, injectability, and *in vitro* performance were evaluated. The coacervate biomaterial, despite being assembled under acidic pH conditions, demonstrated the capability to encapsulate cells, ensuring their long-term viability, by pre-encapsulating the cells within liquified-core capsules formed at the interface of all-aqueous immiscible phases. The engineered material has the ability to be loaded with cells and locally delivered with minimally invasive procedures, opening up new avenues for smart materials in biomedical applications, enabling minimally invasive cell-loaded thermos-responsive delivery systems.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials(UIDB/50011/2020, UIDP/50011/2020 and LA/P/0006/2020), financed by national funds through the FCT/MEC(PIDDAC). This work was also funded by European Union's Horizon 2020 research and innovation programme under the grant agreements INTERLYNK(No. 953169), SUPRALIFE(No. 101079482) and REBORN(ERC-2019-AdG-883370). L.P.G.M., M.C. and J.M.M.R. gratefully acknowledge FCT for the individual PhD grants (2020.06767.BD–L.P.G.M. and 2021.04542.BD–M.C.) and individual researcher contract (CEECIND/01363/2018), respectively.

ABSTRACT 12

Photo-cross-linkable peptide-based hydrogel with tunable microstructure and mechanical properties for tissue engineering strategies

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The extracellular matrices (ECM) of human tissues are dynamic, complex and highly hydrated 3D networks of self-assembled macromolecules organized in a fibrous mesh. Such networks are the result of the assembly of glycosaminoglycans, (GAGs) such as hyaluronic acid (HA) and chondroitin sulphate (CS) with fibrous proteins, such as laminin, elastin or fibronectin. However, the high costs, batch-tio-batch variability, poor processability and limited stability and availability entailed by the ECM proteins hamper their use in assembling human tissues [1]. The ease of synthesis, high stability and chemical versatility, fibrillar topography and high-density display of bioactive cues imparted by the peptide amphiphiles (PA) turn them into suitable alternatives to fibrous proteins when designing ECM-mimetic biomaterials [2]. Although the PA-derived supramolecular biomaterials denote limited stability and structural integrity owing to their soft nature [3], crosslinking strategies have been applied to improve their mechanical properties and suitability to be used in biomedical applications [4]. Herein, HA- and CS-methacrylate derivatives were combined and further co-assembled with PA to enable the formation of a physical network prior to the covalent crosslinking of the methacrylated GAGs, thus leading to 3D networks with tailored mechanical and biological properties. The secondary structure of the hybrid biopolymer/PA co-assembled materials was studied by circular dichroism, thioflavin T assay and transmission electron microscopy. The mechanical properties and microstructure of the biopolymer/PA hydrogels were assessed by oscilatory rheology and scanning electron microscopy, respectively, and compared with individual materials. *In vitro* assays revealed an enhanced viability of cells cultured on hybrid hydrogels when compared to the controls. We envisage that this work will pave the way for the design of hybrid PA-derived hydrogels, denoting emerging properties and multifunctionalities, as tunable ECM mimetics for tissue engineering strategies.

Acknowledgments: This work was funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE"). The financial support by FCT through the PhD grants (M.L.: 2020.05210.BD; V.S.: 2020.06771.BD), and Assistant Researcher contract (J.B.: 2020.00758.CEECIND) is gratefully acknowledge. This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC).

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ABSTRACT 13

Soft sustainable self-standing membranes made of marine-origin polysaccharides as nano-reservoirs for controlled therapeutics delivery

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The development of nano-reservoirs for the encapsulation, protection, transport, and on-demand targeted release of bioactive molecules has been widely explored to date in biomedicine [1, 2]. The Layer-by-Layer (LbL) assembly technology is a highly versatile bottom-up approach to precisely engineer robust architectures, with tunable properties and functions at the nanoscale, by resorting to a myriad of building blocks exhibiting complementary interactions [3]. Chitosan (CHT) and alginate (ALG) are marine-origin polysaccharides widely used in assembling multilayered devices owing to their bioavailability, biocompatibility, biodegradability, and opposite charge nature [4]. However, the insolubility of CHT in physiological conditions limits the incorporation of bioactive molecules into CHT-based LbL structures. Herein, we report the development of electrostatic-driven free-standing membranes made of water-soluble quaternized CHT (HTCC) and ALG for the controlled release of model hydrophobic drugs (Figure 1) [5]. Two set-ups of membranes, having either fluorescein isothiocyanate-labeled bovine serum albumin (FITC-BSA) as an intrinsic building block $(HTCC/ALG/HTCC/FITC\text{-}BSA)_{100}$ or as an outer layer $(HTCC/ALG)_{200}/HTCC/FITC\text{-}BSA$ have been produced. Their morphology, release rate and *in vitro* biocompatibility were studied and compared. The mechanical properties of the membranes made of native and quaternized CHT were also evaluated. This work provides new insights on the use of a water-soluble CHT derivative to develop innovative and sustainable biomedical devices for controlled therapeutics delivery.

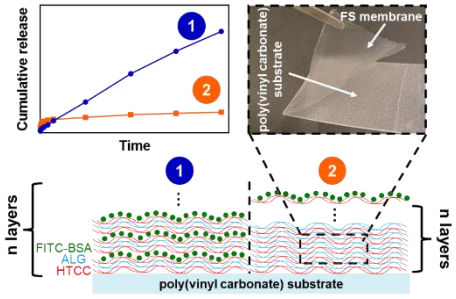

Figure. 1 Schematic illustration of the two set-ups of free-standing multilayered membranes produced: (1) (HTCC/ALG/HTCC/FITC-BSA)100 and (2) (HTCC/ALG)200/HTCC/FITC-BSA and respective cumulative release profile.

Acknowledgments: This work was funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE"). The financial support by FCT through the PhD grants (2020.04408.BD, C.F.V.S.; 2020.06767.BD, L.P.G.M.), and individual Junior Researcher (CEECIND/01363/2018, J.M.M.R.) and Assistant Researcher contracts (2020.00758.CEECIND, J.B.) is gratefully acknowledge. This work was developed within the scope of the project CICECO – Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MEC (PIDDAC).

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ABSTRACT 14

Adhesive coacervate inks for in situ 3D printing

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Bioprinting has arisen as shift paradigm technique in the tissue engineering field, allowing for enhanced mimicry of the 3D hierarchical organization of native tissues [1,2]. Another potential application of this field is the opportunity of real-time printing during a surgical procedure on the patient [3]. This approach allows to adapt the graft to the wound geometry, offering a patient-specific therapy. However, the defect site is frequently highly moisturized, hindering the tight contact between the scaffold and the tissue surface. Therefore, the maintenance of the construct in the desired place remains a challenge. Ultimately, for surgical applications, material inks should rapidly form high-fidelity designs, while adhering to the wound site [4]. In this sense, the capacity to print adhesive material inks is extremely promising and continues to be poorly investigated [5]. In this work, we develop a biomaterial ink through liquid–liquid phase separation (LLPS) between tannic acid (TA) and methacrylic laminarin (LAM-MA). Through the supramolecular interaction between LAM-MA and TA, we produced an adhesive material ink that showed high printing fidelity in a variety of printed patterns, after optimizing the printing conditions. Additionally, the ink proved to be stable for printing in both water and PBS, allowing the formation of multi-layered structures with multi-interface capacities. The adhesive strength, as well as antibacterial properties and cytocompatibility were evaluated. Finally, for proof-of-concept purposes, *ex vivo* printing in a liver tissue was successfully achieved. Therefore, adhesive inks can constitute a new strategy to facilitate seamless tissue integration of the materials in the human body.

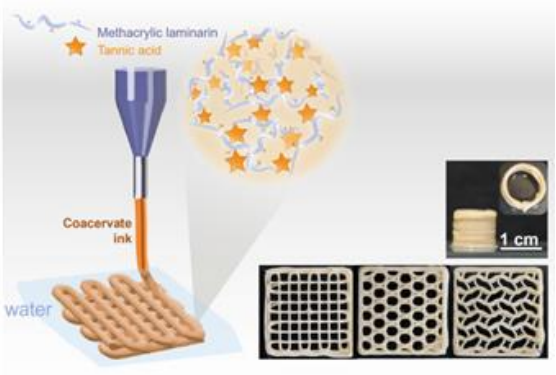

Figure 1. Schematic representation of the material coacervate ink composition (left) and versatility of underwater printing models with four or twenty layers (right).

Acknowledgments: Work developed under the project CICECO-Aveiro Institute of Materials (UIDB/50011/2020 & UIDP/50011/2020), financed by national funds through the FCT/MEC (PIDDAC), and within the scope of the project BLUEGLUE (FA_05_2017_031) financed by Fundo Azul Call – N.º 5/2017 and Direção-Geral de Política do Mar (DGMP) do Ministério Português do Mar. This work was also funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE"). M.M.A.S, R.S.A., M.B.O. and J.M.M.R. gratefully acknowledge FCT for the PhD grant (2020.07156.BD) and individual researcher contracts (10.54499/2022.04605.CEECIND/CP1720/CT0021, CEECINST/00013/2021 and 10.54499/CEECIND/01363/2018/CP1559/CT0022), respectively.

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ABSTRACT 15

Advancing nanocomposite phase interaction to 3D-print natural-derived low-viscous biomaterials

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Ink engineering can advance the printability of better therapeutics, with optimized material proprieties. We describe a methodology for yielding nanocomposite inks (NC) for 3D printing from low-viscous matrices, by the improving the interaction between the organic and inorganic phases by chemical coupling. Two natural matrices were synthesized: a protein – bovine serum albumin methacrylate (BSAMA), and a polysaccharide – hyaluronic acid methacrylate (HAMA); both optimized for appropriate degrees of functionalization. Bioglass nanoparticles (BGNP), as exemplary nanofillers, were synthesized and functionalized via an aminosilane. The functionalization of BSAMA, HAMA, and BGNP were quantified via NMR. To arise extrudable inks, EDC/NHS chemistry was used to link inate carboxylic groups of BSAMA/HAMA to the amine-functionalized BGNP. Different crosslinker and BGNP amounts were tested. The reaction was carried overnight and visible light photopolymerization was performed, using LAP as a photoinitiator. Rheological, mechanical, and biological behavior of the produced NC was evaluated. Both formulations were 3D printed. All composite formulations effectively immobilized and homogeneously dispersed the BGNP, turning low viscous materials into shear-thinning formulations with increased elastic and viscous modulus. More pronounced increments were found with the highest EDC/NHS and BGNP concentrations (10%w/w). Bioactivity in simulated body fluid and cellular assays using adipose-derive stem cells revealed a similar calcium/phosphate ratio to that of hydroxyapatite, and increased viability and metabolic activity on the BGNP-containing formulations.

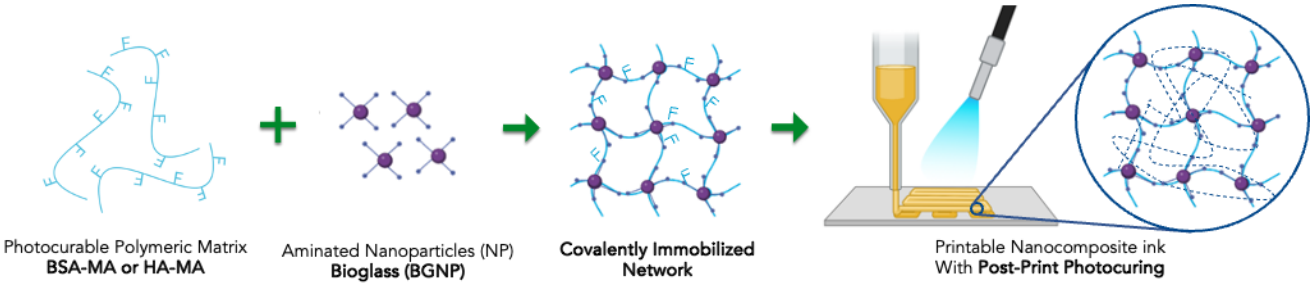

Figure 1. Nanocomposite inks engineered via interfacial interactions within bioactive bioglass nanoparticles and functionalized light-responsive natural-derived biomaterial matrixes for 3D printing.

Acknowledgments: The authors wish to acknowledge FCT for the individual grant of R.S-A (2022.04605.CEECIND) and European Union's Horizon 2020 research and innovation programme under the scope of InterLynk project with grant agreement No 953169, and the research grant BI/UI89/10303/2022. The project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020) financed by national funds through the FCT/MEC (PIDDAC) is also acknowledged.

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ABSTRACT 16

ECM-mimetic photoclickable thiol-ene inks for biomedical applications

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Nowadays, great efforts are focused on reproducing biomimetic and tissue analogues due the lack of appropriate biomaterials and technologies that can accurately reproduce tissue architecture and functionality [1]. Bottom-up three-dimensional (3D) printing techniques have been able to overcome some of these challenges, with the development of structures that can precisely mimic cellular placement and extracellular milieu [2]. Moreover, 3D printing is an enabling technology for personalized medicine since it can be tailored to the demands of individual patients for specific tissue defects. However, challenges including the selection of materials as well as crosslinking strategies still need to be addressed, in order to enhance the inks characteristics and simultaneously create printable, robust, and cytocompatible biomaterials.

Herein, we report the development of natural-based photoclickable inks composed of hyaluronic acid (HA) combined with proteins – bovine serum albumin (BSA) or human platelet lysates (hPL) –, taking advantage of the bio-orthogonality, versatility, efficiency, and fast kinetics of thiol-ene click chemistry [3]. These inks exhibited very fast gelation (t < 20 s) achieving a G' of approximately 10^4 Pa and Young's moduli ranging from 13 kPa to 20 kPa, highlighting their suitability for soft tissue repair applications. Moreover, the mechanical and rheological properties of the inks enabled 3D extrusion printing (Figure 1). *In vitro* experiments revealed the biomaterials cytocompatibility and non-toxicity, demonstrating their potential for future application in tissue engineering and regenerative medicine.

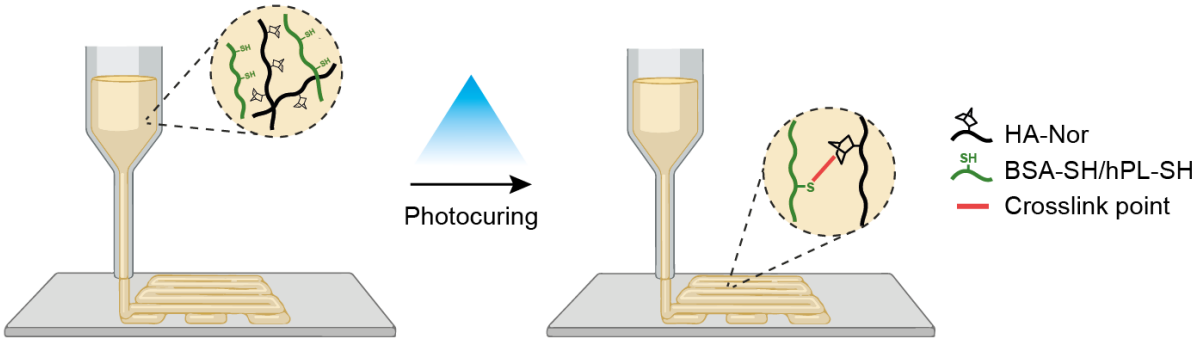

Figure 1. Schematic representation of 3D extrusion printing of photo-clickable inks composed of norbornene functionalized HA (HA-Nor) combined with thiolated proteins (BSA-SH and hPL-SH).

Acknowledgments: Work developed under the project CICECO-Aveiro Institute of Materials (UIDB/50011/2020, UIDP/50011/2020 and LA/P/0006/2020), financed by national funds through the FCT/MEC (PIDDAC). This work was also funded by European Union's Horizon 2020 research and innovation programme under the scope of InterLynk project with grant agreement No 953169. R.S.A (2022.04605.CEECIND) and J.M.M.R. (CEECIND/01363/2018) gratefully acknowledge FCT for their individual researcher contracts.

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ABSTRACT 17

Human platelet lysates-derived fibrils as building blocks to produce free-standing membranes for cell self-aggregation

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Although amyloid-like fibrils are mostly associated with the development of amyloidogenic diseases, these bioactive structures have gained momentum as supramolecular nanofunctional units for biomedical applications [1]. Recent insights on the functionality of such fibrillated protein-derived structures have pointing out the importance of fibrils for tissues' structure, mechanical properties, and improved cell adhesion [2]. Herein, human platelet lysate (PL)-derived fibrils instantaneously produced by the addition of the ionic liquid (IL) choline tosylate are reported and explored as building blocks for the formation of free-standing membranes to support cell self-aggregation. The highly efficient instantaneous fibrillation of PL proteins is fully governed by supramolecular protein-IL interactions and characterized by a high content of β-sheet structures, demonstrating a high cytocompatibility. Through a simple solvent casting process, a thin and flexible free-standing membrane fabricated with PL-derived fibrils reveals a nanotopographically rough surface and high stability over 14 days under cell culture conditions. The culture of mesenchymal stem cells or tumor cells on the top of the membrane demonstrated that cells are able to adhere and self-organize in a 3D spherical structure, while tightly folding the fibril membrane. Results suggest that fibril membrane incorporation in cell aggregates can improve cell viability and metabolic activity, recreating native tissues' histology. Altogether, these PL-derived fibril membranes are suitable bioactive platforms to generate cell-guided aggregates that can be explored as bottom-up strategies to faithfully emulate native tissues in a fully human microenvironment.

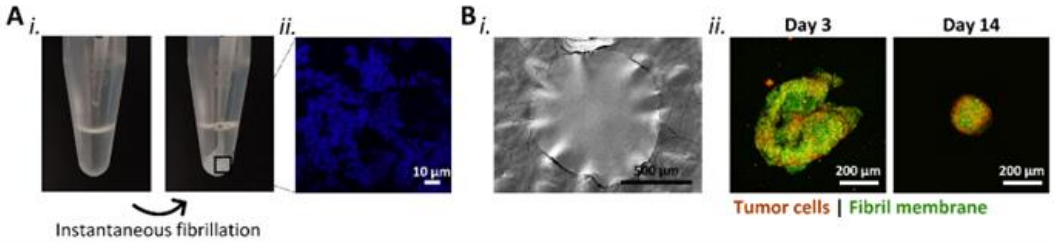

Figure 1. (A) (i) Instantaneous fibrillation of PL-derived proteins and (ii) confocal microcopy images of obtained fibrils (blue). (B) (i) Scanning electron microscopy micrograph of fibril-based membrane fabricated by solvent casting. (ii) Representative confocal images of tumor cells transfected with red fluorescent protein (orange) folding the fibril membrane (green), in a flat surface, at 3 and 14 days of culture.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC). The authors also acknowledge the support of the European Research Council Proof-of-Concept Grant Agreement No. ERC-2020-PoC-957585 for the project Amniogel. This work was also supported by the Foundation for Science and Technology through the individual contract 2020.01647.CEECIND of Dr. Catarina A. Custódio and the doctoral grant SFRH/BD/144640/2019 of Cátia F. Monteiro, and by European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE").

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ABSTRACT 18

Amyloidogenic peptides in the biomimetic design of hybrid biomaterials

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Traditionally linked to pathological conditions, amyloid structures have undergone a paradigm shift in their perception. Indeed, amyloid fibrils, linear proteinaceous aggregates characterized by a cross-β-sheet structure, have been identified in almost all species playing vital functional and structural roles from bacteria to humans [1]. Inspired by Nature, researchers have begun to use amyloid proteins for the fabrication of renewable artificial nanomaterials [2]. The purpose of the current study was to design hybrid biomaterials based on nanocellulose and short amyloidogenic peptides, which, compared to their full-length protein counterparts, offer distinct advantages such as ease of design and synthesis, controlled functionalization and improved stability. Indeed, since halogen atoms have been proved to tailor self-assembly properties of peptides [3,4], site-specific halogenation of selected amino acid residues was used to further enhance their supramolecular behavior. Therefore, exploiting electrostatic interactions and physical entanglements between the two components, the integration of such peptides in the nanocellulose network endowed the final material with improved physical properties and added functionality. Overall, this study provides an example of the versatile potential of short amyloidogenic peptides, contributing to the advancement of biomimetic hybrid biomaterials with applications in diverse fields, from materials science to biomedicine.

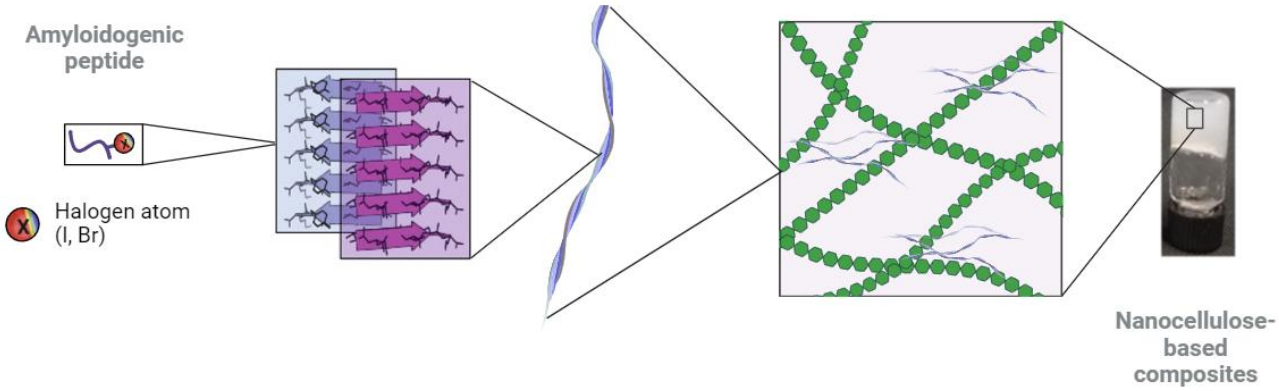

Figure 1. Schematic illustration of the self-assembly mechanism of amyloidogenic peptides bearing halogenated residues and their integration in the nanocellulose network.

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ABSTRACT 19

Tunable and printable nanocomposite networks based on human-derived platelet lysates for interfacial tissues regeneration

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Platelet lysates (PL) have been used in regenerative medicine as a source of growth factors and other bioactive proteins [1-3]. However, 3D printing of protein-based biomaterials remains a challenge due to their lack of rheological and mechanical properties. Moreover, studies have shown that PL-based biomaterials demonstrate poor mechanical properties and degrade in a short time frame during in vitro assays.[2] Maia et al. (2023) showed that the incorporation of nanoparticles in proteinaceous matrices could improve their rheological and mechanical properties and subsequently their printability [4]. Thus, this work presents a strategy to use nano-hydroxyapatite (nHAp) to reinforce PL-based materials in order to confer the necessary properties for 3D extrusion printing. For that, the incorporation of PEI-functionalized nHAp into a solution with PL with its methacrylated counterpart (PLMA) and a photoinitiator was performed using EDC/NHS carbodiimide chemistry. Results showed that the particles tend to agglomerate and have needle-shape morphology. FTIR-ATR and Zeta-potential analysis confirmed their functionalization with PEI and methacrylic anhydride (MA) groups. Rheological tests revealed that inks have shear thinning behavior and are suitable for extrusion printing. Preliminary experiments show the potential to print these nanocomposites. Biological assays demonstrated the huge biocompatibility of these nanocomposites with high live/dead cell ratio and increased metabolic activity.

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ABSTRACT 20

Artificial Internalizing Receptors in Mammalian Cells

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Receptor-mediated endocytosis is one of the core cellular functions and is often exploited for targeted drug delivery. The natural presence of cell surface receptors enables the action of antibody-drug conjugates (ADCs), a highly successful modality of drug delivery. However, targeting natural receptors is often associated with a high risk of off-targets and side effects. We therefore try to develop new dedicated communication routes, which could be essential in improving current cell-based therapies e.g. CAR T cell therapy. Inspired by Nature, we have designed chemical, artificial internalizing cell receptors that mimic the natural process of receptor-mediated endocytosis (Figure 1A). The chemical receptor design includes a cholesterol amine anchor that enables association with the phospholipid membrane of mammalian cells, and a spacer moiety, which separates the anchor from the crucial recognition motif, fluorescein (Figure 1B). This xenobiotic, fluorescent moiety supports the visualization of the artificial receptor and enables extracellular targeting with a cognate anti-fluorescein antibody (Figure 1C). Targeting of the artificial receptor in primary human T-cells using a Monomethyl auristatin E (MMAE)-based antibody-drug conjugate (ADC) was proved to be of nanomolar potency (Figure 1D). Furthermore, the eradication of a receptor-equipped 3D cell spheroid was achieved. This emphasizes the ability to use our artificial receptor in tumour-infiltrating engineered cells, where on-demand deactivation would not only lead to the killing of the equipped cell but also of the surrounding cancerous tissue, by the inherent bystander effect of the released drug (MMAE) [1]. In new unpublished data, we made significant improvements in the receptor-mediated ADC delivery by demonstrating enhanced potency relative to the free drug (70-fold), increased selectivity by elimination of the bystander effect, significantly faster action, and long sustainability of the receptor. These improvements increase the applicability of using artificial receptors in the design of a selective communication route only to the pre-engineered cells, such as a functional “suicide switch” installed in CAR T cells in case unwanted immunological responses or side effects arise. Additionally, we work on investigating the scope and potential limits in terms of cargo that can be internalized using artificial receptors. To do so, we inverted the design and equipped the anti-fluorescein antibody itself with an anchor moiety. This allowed easy incorporation into mammalian cells, with both fluorescein-labelled antibodies and serum albumin being successfully internalized. This highlights that the internalization of cargo is potentially only limited by the ability to be labelled with the commonly used fluorescein moiety. Our artificial fluorescein based recognition system illustrates how the use of xenobiotics can overcome the problems faced when targeted drug delivery is based on naturally occurring antigens [2]. Furthermore, our designs demonstrate how artificial receptors can be very useful tools with many future applications within important areas of biomedicine and biotechnology.

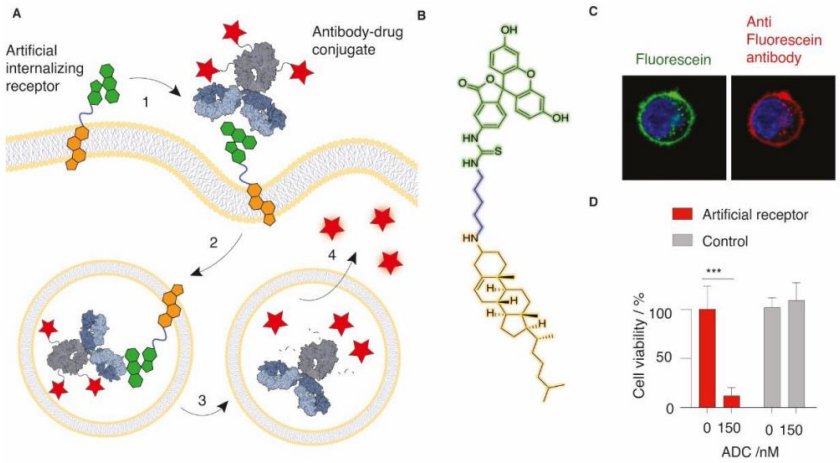

Figure 1. Artificial internalizing cell receptors [1]. (A) Illustration of the artificial receptor-mediated internalization mechanism. 1) Binding of the antibody-drug conjugate to the artificial receptor 2) Internalisation and pH-dependent cargo dissociation 3) lysosomal degradation 4) drug release. (B) Structure of the artificial receptor including the anchor (orange), spacer (purple), and recognition motif (green). (C) Fluorescence microscopy of the artificial receptor and binding of the cognate antibody. (D) Nano molar potency of the antibody-MMAE conjugate in artificial receptor-equipped primary human T cells.

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ABSTRACT 21

Chemical modifications and self-assembly of oligonucleotides to fight against resistance to anti-infective drugs

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Oligonucleotides have been envisioned as a therapeutic treatment since a few decades. A few drugs have been approved today mainly for neurological diseases but no oligonucleotide has been approved for an infectious disease. Their ability to target a specific gene is particularly promising in the case of antibiotic resistance where only a few or no drug at all can be effective, by targeting the resistance gene directly it would be able to restore antibiotic susceptibility. One of the main challenges is the penetration of the oligonucleotide through the membrane of the bacteria. In this work we will present an antisense oligonucleotide lipid conjugate [1] able to self-assemble in micelles and able to decrease antibiotic resistance. Several chemical structures of the backbone have been compared to optimize the therapeutic potential.

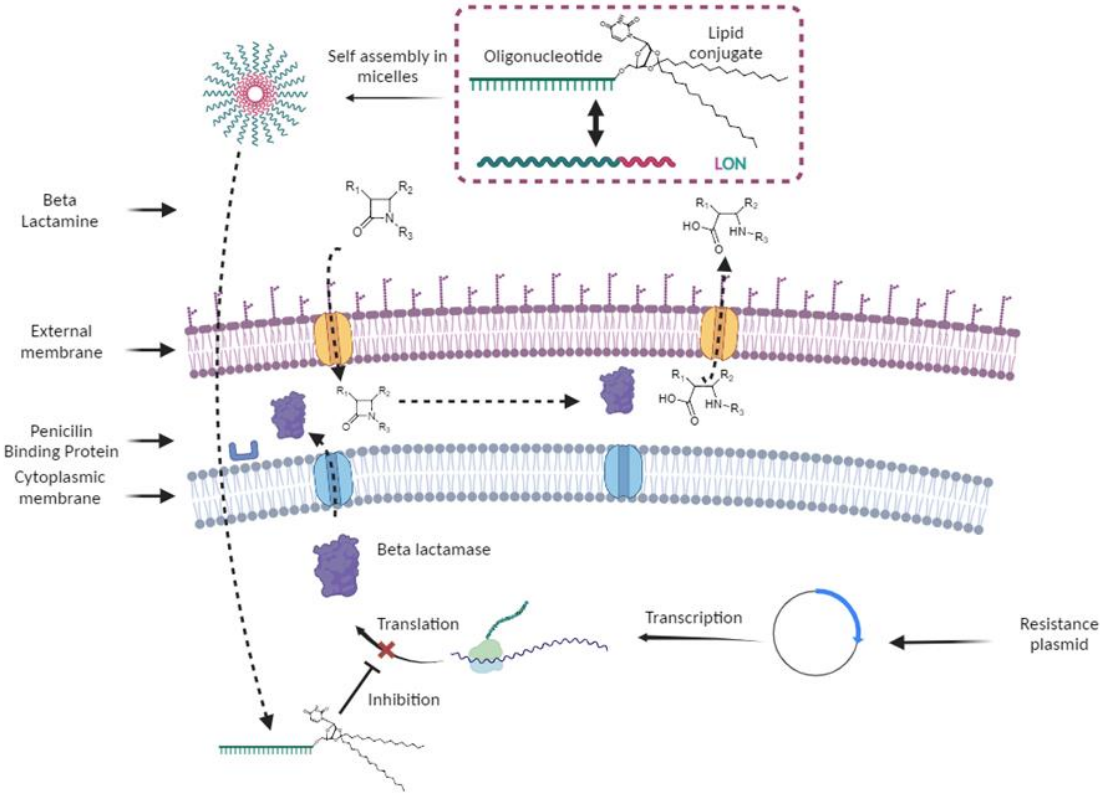

Figure 1. Beta lactamase resistance mechanism and action of the lipid oligonucleotide (LON) with its self-assembly in micelles

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ABSTRACT 22

Navigating combinations of Platelet-rich fibrin with Biomaterials in Dental Surgery

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Platelet-rich fibrin (PRF) is a protein matrix with growth factors and immune cells extracted from venous blood via centrifugation [1]. Previous studies have proved it is a beneficial biomaterial for bone and soft tissue regeneration in dental surgeries [2]. Researchers have been combining PRF with other biomaterials because it is biocompatible and easily modifiable for composite preparation [3]. Although *in vitro* and *in vivo* studies have tested PRF and biomaterial composites and proved superior to any of the components separately, it is difficult to compare the results due to varied research methods, used materials, and types of PRF [3], [4]. Here, we review literature from open-source databases to help readers navigate the field of PRF and biomaterial composites and aid them in selecting a composite that suits their planned research or medical case.

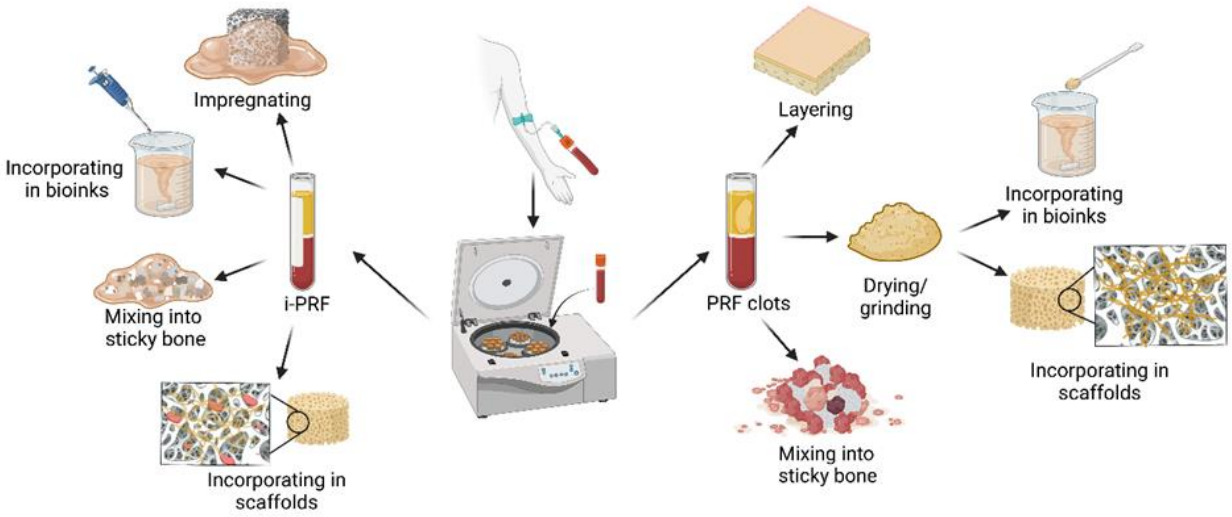

Figure 1. Combining and incorporation of PRF into graft materials based on PRF preparation type.

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ABSTRACT 23

Sedimentation velocity analysis of freeze folded self-interacting short-sequence insect collage: Comparison of biophysical and structural characteristics of kinetically locked structures measured at 5 or 10 °C generate via freeze-induced folding to samples incubated and measured at 30 °C

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Sedimentation velocity analytical ultracentrifugation (SV-AUC) is a classical technique to study hydrodynamic properties of self-interacting proteins in solution based on the size-dependent macromolecular migration in the centrifugal field. Self-interacting proteins are characterized by their intrinsic propensity for the formation of higher order assemblies that are readily captured in SV-AUC experiments allowing for elucidation of assembly scheme, estimation of binding affinity, elucidation of ensemble average shape change upon assembly. All of the which are relevant for understanding the factors affecting phase transition in liquid-liquid and liquid-liquid crystalline phase separation processes. Precise understanding of molecular structure and oligomeric state of the protein in the biomolecular condensates is generally lacking and remain a topic of scientific interest. The current poster demonstrates initial investigation into assembly state of novel short-sequence insect collagen protein in aqueous solution analysed at 30, 10 and 5 °C. Samples at 10 and 5 °C were analysed immediately after thawing in, believed-to-be, kinetically locked state which serves as a “snapshot” of the concentrated-phase composition. Analysis of data at different concentrations suggests the trimer to be a primary component (>80%) in the solution hinting at it being the main structure presents in condensates in LLPS/LLCPS upon freezing. The overall composition stayed constant upon increasing concentration of the protein. Analysing the same system at 30 °C pointed at an interesting peculiarity with respect to monomer sedimentation coefficient. When compared to analysis performed at 5 °C weight average sedimentation coefficient of monomer fraction at 30 °C shifted to a higher value of ~1.6 S from ~1.2 S, indicating substantial change in average shape of the protein in two conditions. Results presented demonstrate a potentially useful approach for studying resulting molecular structures in concentrated phase of short-sequence proteins undergoing LLPS/LLCPS. These findings can potentially provide a way of determining assembly and folding state and elucidate the difference between two phases – dilute and concentrated, enhancing the understanding of molecular structure withing the biomolecular condensates.

Acknowledgments: The authors acknowledge the provision of facilities and technical support by Aalto University at OtaNano – Nanomicroscopy Center (Aalto-NMC). This work made use of Aalto University Bioeconomy Facilities. This research is supported by the Academy of Finland project no. 333238, by the Academy of Finland’s Center of Excellence programme (2022-2029) project no. 346105, as well as by the Novo Nordisk Foundation grant no. NNF23OC0081564.

ABSTRACT 24

Investigating the Co-assembly of Peptide Amphiphiles with Daptomycin to Improve its Pharmacokinetics Towards More Effective Therapies for Severe Bacterial Infections

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Daptomycin, a cyclic lipopeptide antibiotic (Fig. 1A), exhibits potent *in-vitro* activity against a wide spectrum of Gram-positive pathogens, including multidrug-resistant strains. However, despite its effectiveness, treatment failure of daptomycin has emerged as a critical concern, particularly in the context of therapeutically significant species [1]. The co-assembly of the cationic polymyxin B (PMB) lipopeptide with peptide amphiphiles (PAs) of opposite charge into a hydrogel has been previously reported [2]. The gel showed the capacity to temporally control PMB release and incorporate additional antibiotics for combined and synergistic antimicrobial therapies. Herein, we investigate the possibility of applying a similar co-assembly approach for daptomycin to achieve controlled and sustained release of the antibiotic at the infection site. We have designed 2 PAs (Fig. 1B, C) that display similar and complementary structural features with daptomycin. The PAs are synthesized via solid-phase peptide synthesis and characterized through a range of spectroscopic and microscopy methods (CD, Fluorescence, Zeta potential, and TEM) to investigate their self-assembly properties. This communication will present the outcomes of our co-assembly studies as well as preliminary antibacterial assays with relevant pathogens.

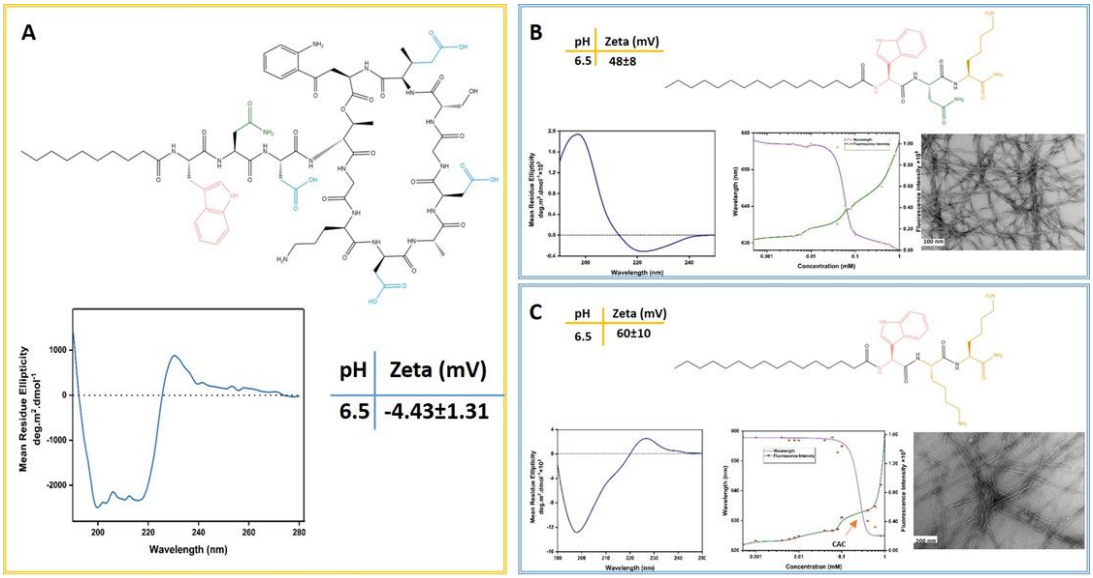

Figure 1. Chemical information of A) Daptomycin, B) PA1 and C) PA2

Acknowledgments: RK thanks the financial support by The Royal Society of Chemistry (UK) for providing a Researcher Development and Travel Grant to attend this event. RK and HSA thank the MOBILIsE project funded by the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 951723 for supporting the research work.

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ABSTRACT 25

A visible light responsive amphiphile

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Amphiphiles with interfacial properties that are addressable by an external stimulus have applications ranging from industrial processes to drug delivery. Our project aims to design visible light switchable amphiphiles, based on merocyanine [1,2], and study the response of their self-assembly to visible light. Our preliminary results show that at sufficiently high concentrations in water our amphiphile self-assembles into spherical structures. These structures reversibly form smaller aggregates under irradiation with blue light, reassembling into spherical structures in the dark.

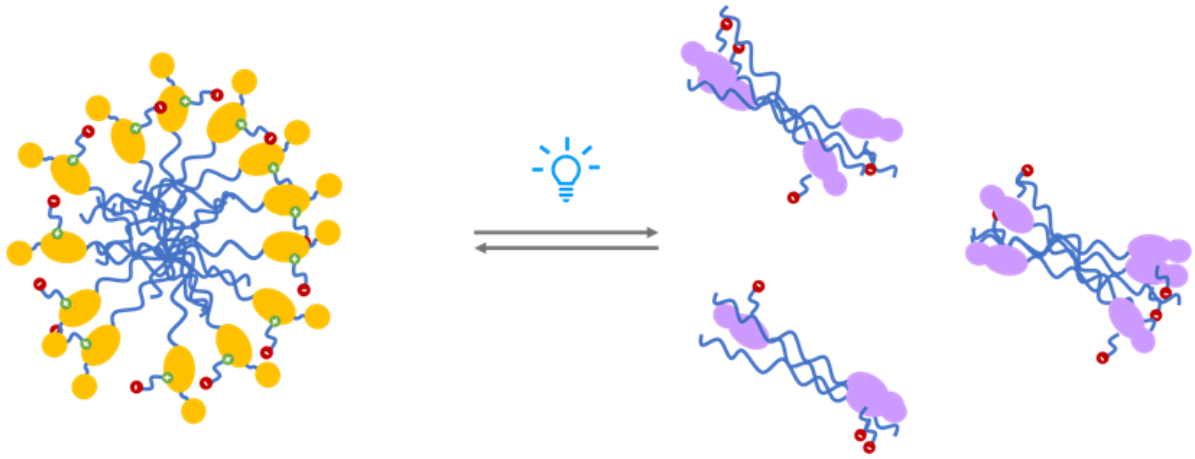

Figure 1. Cartoon representation of the assemblies of photoswitchable amphiphile.

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ABSTRACT 26

Bioinspired Processing of Complex Coacervates for Advanced Materials

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Complex coacervation is an associative liquid-liquid phase separation phenomenon driven by electrostatic attraction between oppositely charged macro-ions (e.g. polysaccharides, proteins etc.) and counter-ion release, resulting in a polymer rich aqueous phase in equilibrium with a polymer poor phase [1]. For a given polyelectrolyte couple, depending on the salt concentration of the medium, a complex coacervate either behaves as a free-flowing viscoelastic fluid or a rigid polyelectrolyte complex or anything in between [2]. This outstanding versatility has made complex coacervates good candidates for a wide range of applications [3]. In the Kamperman group at the Zernike Institute for Advanced Materials at the University of Groningen, we are dedicated to improve and engineer complex coacervates to introduce novel advanced functional materials such as underwater adhesives [4], double network hydrogels, 3D printing biomaterial inks and responsive Pickering emulsifiers micelles. In this presentation, I will particularly focus on the use of hyaluronic acid – chitosan complex coacervate as a biomaterial ink for 3D printing. By carefully optimizing, the physico-chemical parameters of the system, meaning pH, salinity and molecular weight of the polymers, we were able to produce a set of biomaterial inks that can be used in different environmental conditions. The developed inks can not only be dried and rehydrated without loss of shape fidelity, but also be printed into a liquid medium (fresh-printing) without the need of any chemical modification or post-printing curing process. These promising results show the potential of coacervate-based biomaterial inks to be used as 2D and 3D scaffolds in cell culture studies.

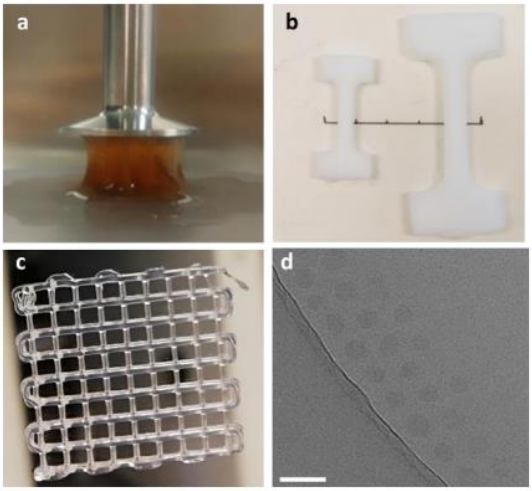

Figure 1. Applications of complex coacervates as a) underwater adhesive, b) sacrificial network for double network gels, c) ink for 3D bioprinting and d) emulsion stabilizer micelles. Scale bar is 100 nm.

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ABSTRACT 27

Streamlining structural proteins production, purification and study their self-assembly in a cell-free system.

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Structural proteins are an important class of proteins with a modular and repetitive sequence composed by hydrophobic amino acids (e.g. silk, elastin, collagen). These proteins organize into supramolecular structures to produce materials essential to Life. They find application on bio-based materials, due to their excellent physical and mechanical properties, as well as sustainability. However, recombinant production in *E.coli* requires time-consuming optimizations and often these proteins are produced in the insoluble fraction with low yields. Besides, chaotropic agents or organic solvents are required for solubilization and during purification [1]. These conditions induce conformational changes, with impact in the supramolecular assembly. In recent years, cell-free expression (CFE) emerged as a strong strategy for production of soluble proteins (e.g. antibodies) and "difficult to express" proteins in high quantities. However, CFE with structural proteins is in its infancy, with 2 pilot reports for silk in the 80s without production yields [2]. Here we show a strategy for production of a silk-like protein derived from cephalopods teeth – suckerin. These proteins form fibres and they assemble into a supramolecular network where nanoconfined β-sheets are randomly oriented within an amorphous matrix [3]. We performed a time course analysis of the CFE production and identified conditions with similar or higher productivity when compared with cell-based expression. As well, we show a simple strategy for purification in aqueous media. We characterize the self-assembly by SEM and optical microscopic (with or without Congo Red staining). During CFE, suckerin assembles into particles and fibers. When stained with congo red, these assembles have green birefringence characteristic of β-sheet based aggregates (like amyloid structures). Finally, this strategy is a stepping-stone in the study of structural proteins and can be applied to other proteins that form supramolecular structures.

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ABSTRACT 28

Characterization of Reflectins' Dynamic Self-Assembly

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A fascinating source for developing bio-based and sustainable materials involves reflectins, the structural proteins found in cephalopods. In vivo, reflectins function as static and dynamic biological Bragg-reflectors responsible for cephalopods' camouflage [1]. Optical properties are triggered by phosphorylation/dephosphorylation events that promote protein assembly/disassembly into high-order structures [2]. We studied in vitro the stimuli-induced reversible self-assembly of reflectins. For that, two protein sequences were selected with different amino acid sequences, derived from static iridocytes (light organ reflectors), and from dynamic iridocytes (cephalopods' skin). Both proteins were recombinantly produced and purified. They were further characterized by circular dichroism (CD), dynamic light scattering (DLS) and atomic force microscopy (AFM) to assess reversible self-assembly into nanoparticles in function of pH. Our experimental data was supported by molecular simulations at different pH conditions using coarse grained reflectin models. According to our results, the amino acid composition of each reflectin greatly impacts their final biophysical properties and reversible self-assembly to external stimuli. Our study contributes to understand the self-assembly mechanism of reflectin proteins, with impact in the design and engineering of bio-based advanced functional materials.

Acknowledgments: This work has received funding from Fundação para a Ciência e Tecnologia (Portugal) for projects PTDC/BII-BIO/28878/2017, PTDC/CTM-CTM/3389/2021, and Research Unit on Applied Molecular Biosciences – UCIBIO (UIDP/04378/2020 and UIDB/04378/2020) and Associate Laboratory Institute for Health and Bioeconomy – i4HB (LA/P/0140/2020). The authors thank FCT/MEC for the research fellowship SFRH/BD/147388/2019 for I.L and 2022.11305.BD for C.S.

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ABSTRACT 29

From Nature to Innovation: Biotechnological Production, Purification, and Processing of cephalopod-specific proteins

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The remarkable ability of octopuses to camouflage has been an inspiration for developing innovative bio-based materials. In our work we explore the cephalopod-specific proteins called reflectins. These proteins self-assemble into nanostructures which manipulate the incident light contributing to camouflage ability of these animals [1]. This study focuses on advancing biotechnological methods for the production and purification of reflectins. We explored purification strategies for two reflectin sequences recombinantly expressed in a bacterial host at lab scale and developed a non-chromatographic method, based on inclusion bodies washing, yielded promising results. This method was more productive when compared to conventional chromatographic purification strategies. Moreover, we achieved protein purity exceeding 90% and purification yields up to 88%. These findings contribute to defining cost-effective bioprocessing strategies in and economically viable protein-based materials.

Acknowledgments: This work has received funding from Fundação para a Ciência e Tecnologia (Portugal) for projects PTDC/BII-BIO/28878/2017, PTDC/CTM-CTM/3389/2021, and Research Unit on Applied Molecular Biosciences – UCIBIO (UIDP/04378/2020 and UIDB/04378/2020) and Associate Laboratory Institute for Health and Bioeconomy – i4HB (LA/P/0140/2020). The authors thank FCT/MEC for the research fellowship SFRH/BD/147388/2019 for I.L. and 2022.11305.BD for C.S.

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ABSTRACT 30

Designing DNA origami-based and enzyme powered nanomotors: Towards controlled nanobot-cell interactions

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Motile processes in nature and biology are essential for the existence and proper functioning of living organisms. From the micro- to the nanoscale, motility of cells and their components is of great importance for the understanding of complex intra- and intercellular processes and interactions. Mechanical processes such as cell migration and division are examples of motility on the micrometre scale. However, all these processes are accompanied by even smaller nanomotors such as kinesins walking on microtubules or myosin exerting force on actin filaments. These biological nanomotors are protein enzymes that convert chemical energy (in the form of ATP) into mechanical energy or force [1]. Inspired by these motors, researchers have endeavoured to find artificial nanomotors that, similar to the aforementioned biological motors, convert chemical energy into mechanical motion [2]. There are numerous examples of investigations performed on both organic and inorganic nanomotors in aqueous as well as more complex environments [3-5]. However, the application of such motors in medical technology is currently limited. One of the key aspects to reach application in the medical field is a key understanding of the interaction of the nanomotors with living cells and their influence on cellular functioning and behaviour. Besides, cells are highly dependent on multivalent interactions to perform specific functions; an effect that is induced by the specific binding of different signalling moieties at the same time. By exploiting multivalent nanoparticle-cell interactions, it is thought that the therapeutic efficiency of the nanoparticle increases. To test this hypothesis, it is necessary to create programmable and highly defined nanomotors that are able to interact with living cells in such a way that they are eventually able to induce and modulate desired cell responses in an efficient manner [6]. In order to create highly defined and programmable nanomotors, the nanomotor should have a design that is controllable and reproducible. To do so, we will use DNA origami-based structures decorated with functional proteins and enzymes. DNA-origami is a technique that allows for the controlled and site-specific incorporation of ligands and other (protein) moieties. This allows for excellent control on stoichiometry and orientation of both the motors as well as the functional proteins intended to interact with living cells. Here, we make use of a rod-like DNA-origami structure that features 24 radially distributed DNA handles to which specific functional components or ligands can be coupled via DNA hybridization (fig. 1).

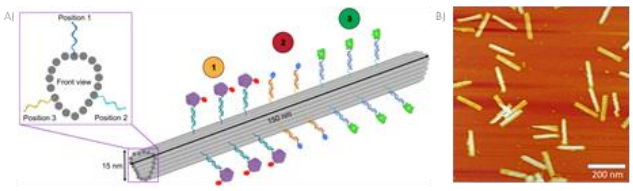

Figure 1. A) Graphical representation of the DNA nanorod containing radially distributed DNA handles that allow for the incorporation of motor enzymes (1), fluorescent dyes (2) and functional cell signalling ligands. B) Visualization of the DNA origami-based nanorods as observed after atomic force microscopy (AFM).

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ABSTRACT 31

In-Situ Structure Formation in Living Cells via Stimulus-Responsive Peptide Assembly

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Supramolecular assemblies in nature are the embodiment of creating function through structure formation. In recent years, these complex natural architectures have inspired the development of materials for the in-situ formation of synthetic nanostructures inside living cells [1]. Synthetic intracellular assemblies can be used to modulate cellular processes [2,3], however, their effects on cellular processes and metabolism have not been widely explored. Herein, we present bioresponsive kinked peptides that can undergo a multistep transformation into self-assembling linear peptides in living cells. We studied the cellular impact of the in-situ formation of peptide nanostructures in cancer cells and analysed the effects on the mitochondrial network. The intracellular peptide assembly causes metabolic disruption and rapid cell death. This work showcases the potential use of bioresponsive nanomaterials as supramolecular anticancer drugs via the construction of synthetic architectures inside living cells.

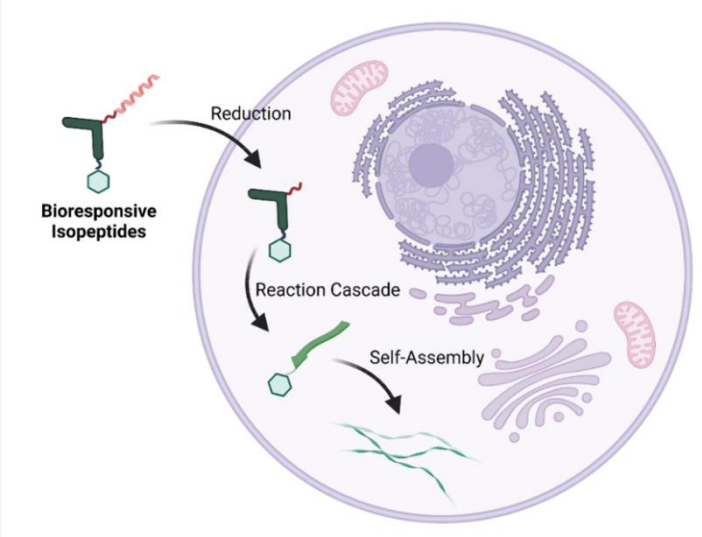

Figure 1. Multistep reaction cascade of glutathione-responsive isopeptides for intracellular assembly.

Acknowledgments: This work was supported by the Max Planck Graduate Center (MPGC) with the Johannes Gutenberg University Mainz.

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ABSTRACT 32

Programmable Nucleic Acid Self-Assembly Guiding Protease Detection

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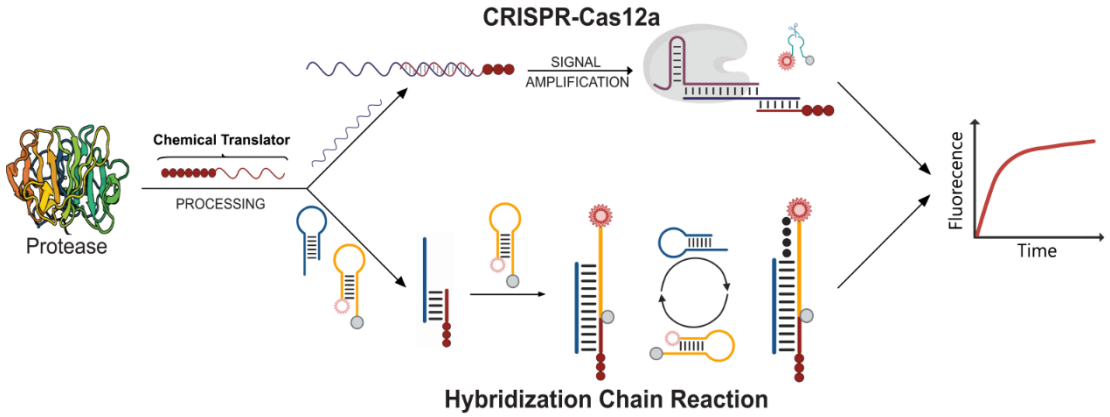
DNA nanotechnology utilizes synthetic DNA molecules to design precise nanoscale structures and nanodevices leveraging predictable base pairing [1]. An application of this concept involves using DNA self-assembly to process and convert the activity of specific proteins into measurable outputs. In this study, we propose novel activity-based detection strategies for matrix metalloproteinase-2 (MMP2), an important protease biomarker for various types of cancer [2]. Our approach utilizes DNA self-assembly to form supramolecular architectures serving as scaffolds for the integration with either CRISPR-Cas12a or HCR. To achieve this, we used a chimeric peptide-PNA chemical translator. The peptide unit is the substrate of MMP2, while the PNA unit enables the conversion of peptide cleavage into a nucleic acid output, which can be subsequently processed and amplified. One approach leverages CRISPR-Cas12a for signal amplification. Incorporating a single-stranded DNA partially hybridized with the PNA sequence of the translator allows for activating the nuclease activity of Cas12a upon hybridization. This is used to degrade rationally designed labeled DNA reporters, resulting in an amplified fluorescence signal. This approach enables the detection of MMP2 in the low picomolar range, outperforming commercial peptide kits. A second approach explored HCR as a strategy for supramolecular structures enabling signal amplification. This technique involves the sequential hybridization of short DNA hairpin probes to a target nucleic acid, inducing the self-assembly of long DNA polymers. The design of orthogonal DNA strands allows simultaneous detection of different proteases, underscoring the versatility of our DNA-based platforms.



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ABSTRACT 33

Lipid-Coated DNA Nanoparticles for Drug Delivery

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The development of efficient drug delivery systems holds great promise for advancing therapeutic interventions. Leveraging the self-assembly of DNA-based nanoparticles (NPs) through Watson-Crick base-pairing, we aim to develop a drug delivery system that provides complete homologous dosing of its cargo. In this study, we investigate the engineering of a DNA-based NP with a lipid coating, aimed at facilitating cytoplasmic drug delivery. The research encompasses the investigation of fundamental interactions between lipids and double-stranded DNA (dsDNA), with a focus on optimizing DNA-lipid interactions and minimizing DNA-DNA interactions to prevent aggregation. Parameters such as lipid composition, DNA concentration, and ion composition were examined to understand their impact on stability and binding affinity. These findings were utilized to develop a lipid-coated DNA-based NP, evaluated for coating efficiency and characterized for physicochemical properties (Figure 1). Preliminary cell uptake experiments demonstrated the potential of the particle for efficient drug delivery. This study provides insights for optimizing DNA-lipid interactions and lays the groundwork for the development of a lipid-coated DNA-based NP with potential applications in cytoplasmic drug delivery. Further research will focus on enhancing the drug loading capacity, fine-tuning the particle design, and evaluating the therapeutic efficacy of this novel drug delivery system.

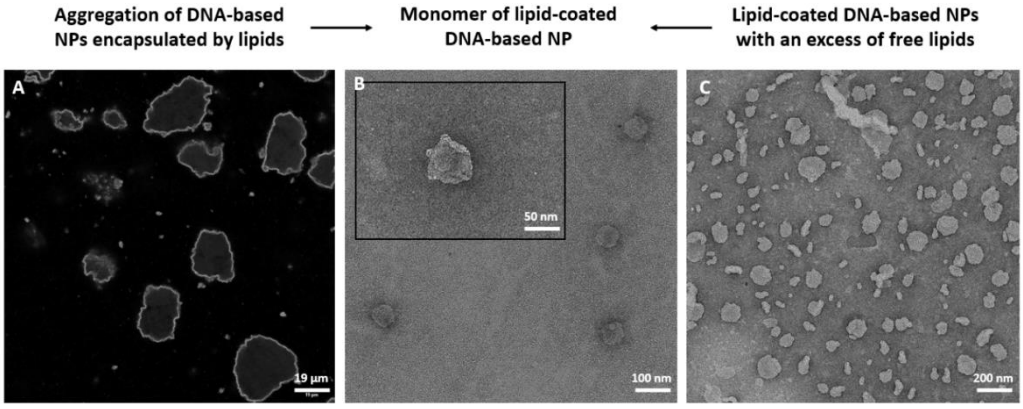

Figure 1. Optimization DNA concentration vs. lipid concentration to reduce the aggregation of DNA-based NPs in case of an excess of DNA included or free lipids in case of an excess lipids included for the developed lipid coating method. A) Confocal image of aggregated DNA-based NPs encapsulated by lipids. B) TEM image of obtained monomer of the lipid-coated DNA-based NPs C) Lipid-coated DNA-based NPs with an excess of free lipids.

Acknowledgements: We thank the FNRS (FRIA Grant to PH) and the ERC Starting Grant InActioN (588561 to MMCB) for funding this research project.

ABSTRACT 34

Selenium, Gadolinium (III)-doped carbon dots as multimodal platforms for medical imaging and therapy

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Carbon dots (CDs) are zero-dimensional quasi-spherical carbon nanomaterials smaller than 10 nm. Due to their inherent properties including tunable photoluminescence, good water solubility, and especially their low cytotoxicity, they have been studied for many applications in biomedicine [1]. Furthermore, the incorporation of heteroatoms in CDs has also been exploited to add functionalities to the material. Selenium plays important roles in selenoproteins, such as glutathione peroxidase (GPx), which are essential for regulating the redox homeostasis in the body [2]. Meanwhile, gadolinium has been used in Magnetic Resonance Imaging (MRI) contrast agents owing to its paramagnetic effect. However, due to the toxicity given by Gd(III)-leakage, the incorporation of these ions into more stable environments is to be pursued [3]. Considering all this, the present work aims to develop selenium, gadolinium (III)-doped CDs (Se,Gd(III) CDs), a platform possessing a dual nature as an MRI contrast agent and an antioxidant. The synthesis of Se,Gd(III) CDs has been performed with a bottom-up approach, through microwave-assisted hydrothermal reactions. Se,Gd(III) CDs, having a mean size of 5 nm, were determined to contain 1.5% and 3% w/w of selenium and gadolinium, respectively. The antioxidant properties of the material have been verified with colorimetric assays. Moreover, good magnetic properties have been demonstrated by the high r1 and r2 values obtained with relaxation measurements, suggesting its possible use as a positive contrast agent. Finally, the stability of the material has been established for over 15 days. The successful development of Se,Gd(III) CDs could confer theranostic benefits in inflammation-based and reactive oxygen species (ROS)-linked diseases.

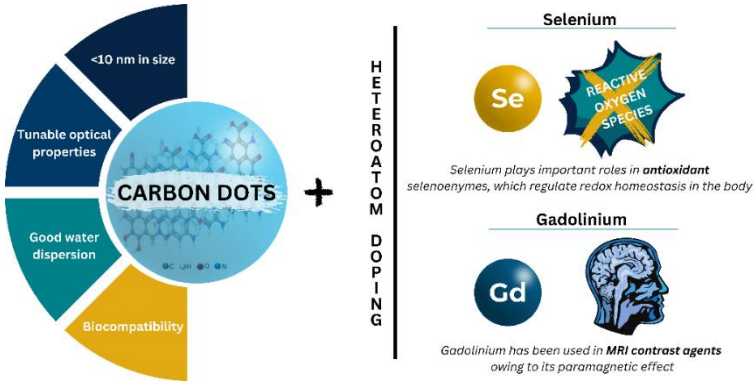

Figure 1. Se, Gd (III)-containing carbon dots as a potential dual-mode platform for biomedical applications.

Acknowledgements: M.P. is AXA professor and this project is supported by the European Research Council (ERC-AdG-2019, N. 885323) and the Agencia Estatal de Investigación-AEI ("Proyectos I+D+I 2019 - Modalidad Retos Investigación", N. PID2019-108523RB-I00).

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ABSTRACT 35

Diverging conformations guide dipeptide self-assembly into crystals or hydrogel biomaterials

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Short peptides are attractive building blocks for supramolecular biomaterials with encoded bioactivity and good cytocompatibility for a variety of applications, spanning from regenerative medicine to innovative therapeutic solutions. Furthermore, the introduction of D-amino acids at selected positions offers a convenient strategy to modulate their durability and resistance against enzymatic hydrolysis, whilst maintaining bioactivity. Aliphatic and aromatic amino acids are ideal residues to prompt self-assembly in water. For instance, a series of cyclo(Phe-Phe) and cyclo(Leu-Phe) stereoisomers was reported to self-assemble into gels with good cytotoxicity and mild antimicrobial activity on S. *aureus* [1]. However, the high hydrophobicity of these dipeptides rendered their handling in water a challenge. In order to develop more water-soluble candidates, linear dipeptides have been studied. Even single-atom modifications can have dramatic effects on the macroscopic outcome of self-assembly towards gels or crystals [2]. Therefore, we undertook a deeper investigation using combined theoretical and experimental approaches. This study revealed key insights for the prediction of the assembling ability of dipeptides in water through a conformational analysis, which showed different distributions of conformers for dipeptides that self-organize into crystals, stable gels, or metastable gels that turn into crystals over time [3]. Furthermore, the structuring role of water in the self-assembly process of dipeptides was revealed [4]. We are currently using this information to map the ability of hydrophobic dipeptides to self-assemble into gelling nanofibers and nanotubes that could pave the way towards various bioapplications [5].

Acknowledgments: This work received funding from FCT - Fundação para a Ciência e a Tecnologia, I.P., in the scope of the project UIDP/04378/2020 and UIDB/04378/2020 of the Research Unit on Applied Molecular Biosciences – UCIBIO, the project LA/P/0140/2020 of the Associate Laboratory Institute for Health and Bioeconomy - i4HB, and European Union's Horizon 2020 program under grant agreement No. 899732 (PURE Project). The authors thank the support of Royal Society of Chemistry grant (R22-1009764370).

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ABSTRACT 36

Tannic Acid/Polyamino Acid Layer-by-Layer Coatings and Their Interaction with Human Cells

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Tooth loss is one of the most prevalent problems that affect life quality. Dental implants are used as tooth substitutes, but periimplantitis disease occurs with time after surgery. Periimplantitis is an inflammatory process around the dental implant caused by bacteria [1]. Antibiotics are the treatment used against it, but current research has identified bacterial resistance as problem and the urge of finding new treatments. We have previously studied the formation of tannic acid (TA) coatings on Ti surfaces to promote tissue regeneration and prevent bacterial biofilm formation [2]. Now we aim at improving the method by combining TA with different polyamino acids (PAA) in a layer-by-layer (LbL) coating with the goal of improving the biocompatibility the coatings. Precise control of the LbL formation and interaction with biomolecules and cells must be studied. Real time LbL deposition was studied with Quartz crystal microbalance with dissipation (QCM-D) in titanium (Ti) sensors. LbL coatings were made by combination of TA different PAAs such us Poly-L-lysine (PLL) and poly-L-arginine (PLR) under flow conditions. FTIR and UV-VIS were used to determine the chemical/physical interaction between TA-PAAs. Release and antioxidant capacity studies were performed to evaluate the effect of PAA in TA properties. Viability of human gingival fibroblasts was assessed using LDH and resazurin assays, while cell morphology was determined using CLSM

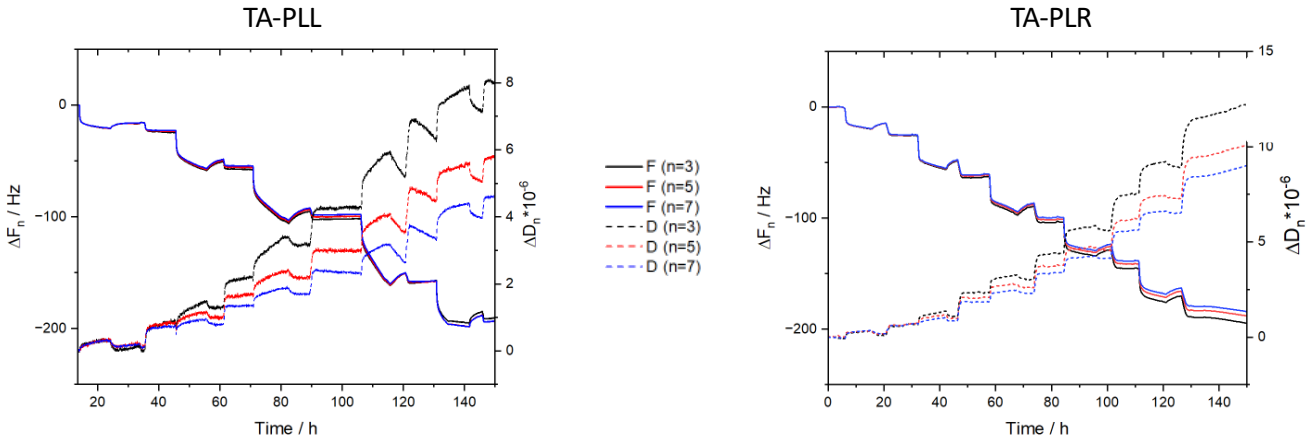

Figure 1. Real-time monitoring of ΔF and ΔD overtones (n=3, 5, 7) for TA-PLL/TA-PLR on QCM-D

Acknowledgments: This work was financially supported by the Research Council of Norway (grant# 302590).

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ABSTRACT 37

Engineering of DNA-nanostructures for the modulation of intracellular pathways

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Interactions between DNA and proteins are fundamental processes in biology. They govern functions ranging from transcriptional regulation to immune signalling and therefore pose attractive targets for biomedical research. The understanding of the junctions between these two biological entities, which in many cases form intricate structural arrangements, is crucial for the development of novel therapeutics. DNA origami provides a versatile platform for the simulation of these intersections and their stimulation. Using supramolecular self-assembly we can with nano-meter precision recapitulate these junctions and study the activation of intracellular pathways upon exposure of the involved proteins to different variations of their putative DNA-targets. By providing these proteins with preassembled structural DNA-entities we opt to remove rate limiting aspects of the assembly of the complexes of interest to allow for enhanced activation of the associated pathways. The engineering of these DNA-origamis involves computationally aided rational design, that is validated by molecular dynamics simulation prior to synthesis of the required strands using phosphoramidite chemistry. Testing of the particles is performed in vitro and subsequently in cellulo and the formation of the complexes under native conditions can be studied by means of cryo-electron microscopy.

Acknowledgements: We would like to thank Penbiao Xu and Andrea Ablasser for their support in the development of the assays required to study the activation of the intracellular pathways and the ERC Starting Grant InActioN (588561 to MMCB) for funding this work.

ABSTRACT 38

Fluorescent carbon nanomaterials with innovative and multifunctional features for biomedical diagnostic and imaging applications

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Carbon dots (CDs) are nano-sized carbon materials that present high water-solubility, high biocompatibility, excitation-dependent photoluminescence behaviour, and high resistance to photobleaching[1]. Besides their synthesis, the application of new purification criteria is useful to achieve more reliable CDs, free from the interference of artifacts. A smart selection of the precursors for CDs synthesis allows to tune their physicochemical properties, for that reason there is a growing interest in the optimization of CDs doping with metals to impart specific characteristics to the final nanoparticles. This thesis is focused on the synthesis and purification of Gd(III) doped Carbon dots (GdCDs) as positive contrast agents for Magnetic Resonance Imaging (MRI) applications. Recently GdCDs with high solubility, biocompatibility, and relaxivity properties have been produced to enhance the characteristics of Gd(III) as a contrast agent[2]. In this work, GdCDs has been synthetized from Gd DTPA and β-Alanine via microwave assisted synthesis (Figure 1) and purified via filtration, dialysis, and Ion Exchange chromatography. Using an already formed contrast agent in the synthesis we aim at achieving higher stability of Gd(III) with respect to previously published synthesis of GdCDs, moreover our goal is to obtain a system with higher cell penetration and biocompatibility with respect to the lone contrast agent. The so-synthetized and purified GdCDs presents good homogeneity (3.5 - 7.5 nm), high Gd content (22% w/w), suitable longitudinal relaxivity (r1), and emissive properties, resulting suitable for combined MRI and Fluorescence Imaging (FI) applications. Still in vivo and in vitro experiments have to be performed.

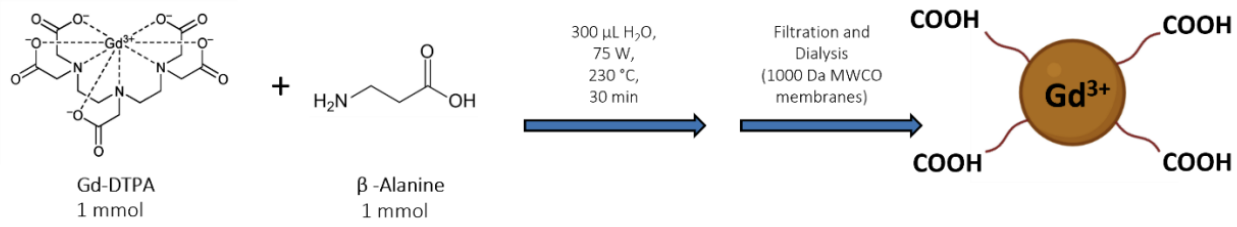

Figure 1. Synthesis of Gadolinium-doped Carbon Dots with a microwave-assisted method.

Acknowledgments:: M.P. is AXA Professor and this project is supported by the European Research Council (ERC-AdG-2019, N. 885323) and the Agencia Estatal de Investigación-AEI ("Proyectos I+D+I 2019 -Modalidad Retos Investigación", N. PID2019-108523RBI00).

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ABSTRACT 39

Polylysine-coated Surfaces Drive Competition in Chemical Reaction Networks to Enable Molecular Information Processing

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Feedback loops dynamically tune the concentration of chemical components in living systems, thereby controlling regulatory processes in neural, genetic, and metabolic networks. Advances in systems chemistry demonstrate that chemical feedback could be designed based on similar concepts of using activation and inhibition processes [1,2]. Most efforts, however, are focused on temporal feedback whereas biological networks are maintained by the interplay between temporal and spatial organization. Here, we designed a feedback system comprising a simple acid-base equilibrium that can be perturbed by two opposing activation processes [3]. Crucially, one of the processes is immobilized on the surface of a microfluidic channel using poly-L-lysine (PLL). We measured the capacity of the PLL-coated channels to resist changes in pH in flow using a pH-sensitive indicator, phenol red, and showed that this capacity can be increased by employing polyelectrolyte multilayers. Specifically, we found that the rate of local activation (i.e., the deprotonation of the immobilized lysine residues) could be significantly increased to delay the otherwise fast equilibrium. This effect allowed for encoding read and write operations, providing the potential to bestow CRNs with the capacity of molecular information processing.

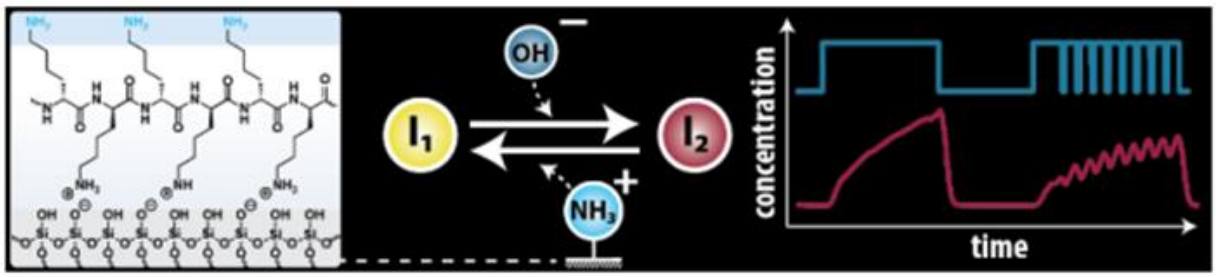

Figure 1. Competing activation network motif that enables molecular information processing. A microfluidic channel with polylysine-coated surfaces could delay an otherwise fast acid-base equilibrium. Control over the rates of protonation and deprotonation allows for molecular information processing.

Acknowledgments: The project is supported by the Netherlands Organization for Scientific Research (NWO, Veni Grant 202.155 to A.S.Y.W; TOP grant 715.015.001 to J.H.) and by the Weijerhorst Foundation.

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ABSTRACT 40

Towards stimulus-responsive motility of artificial cells

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Inspired by nature, researchers aim to create complex and multi-functional systems that possess life-like properties, such as compartmentalization and metabolism. However, mimicking cellular motility has been much less explored in the artificial cell field, which might be caused by the lack of structural similarities between artificial and natural cells. Besides, the incorporation of motion dynamics in artificial cells is challenging. The general aim of this research is to design a novel engineered artificial cell platform, which contains motility and adaptive life-like features. The artificial cell platform that is utilized in this work is based on coacervates, where the inside of the coacervate is densely crowded due to the liquid-liquid phase separation of charged amylose biopolymers. In addition, this phase-separated polymer-dense droplet is stabilized with a poly(ethylene glycol)-b-poly(ε-caprolactone)-g-poly(trimethylene carbonate)-b-poly(glutamic acid) (PEG-b-PCL-g-PTMC-b-PGlu) triblock polymer. The self-assembly of this polymer at the surface of the coacervate droplet is based on multiple aspects. The first one is the electrostatic attraction between the polyanionic poly- (glutamic acid) block and the overall positive charge of the amylose droplet. This is also referred to in the study by Mason et al. as 'electrostatic anchoring'. The second important concept is the buoyancy of the hydrophilic PEG block. This buoyancy prevents the terpolymer from being drawn into the interior of the coacervate, which possesses an overall positive charge. The third property is the hydrophobic effect which drives the membrane formation at the surface of the coacervate droplet [1]. An interesting feature of this terpolymer membrane is the fluidity of the polymer units within the membrane at room temperature, as demonstrated by FRAP experiments [2]. It was shown that surface-attached enzymes possess a high lateral mobility and position themselves stochastically in time and space. This stochasticity imparts transient asymmetry, which can cause motion of the artificial cells in the presence of the substrate [3]. In this project, we aim to explore this asymmetry without solely relying on the stochastics of the system, by making the asymmetry formation process stimulus-responsive. In figure 1, the concept of our stimulus-responsive enzyme clustering is depicted. In this system, elastin-like polypeptides (ELPs) are conjugated to the catalase (CAT) motor enzymes. These ELPs act as a hydrophobic anchor and incorporate into the terpolymer membrane of the coacervate due to their LCST behavior, which implies that they can reversibly change their hydrophobicity based on temperature changes [4]. Next to using the ELPs for hydrophobic anchoring, we aim to cluster the ELPs together via the addition of ammonium sulfate. The design rationale is that this salt-mediated clustering of the ELPs induces asymmetry which leads to directional motion of the coacervate-based micromotor.

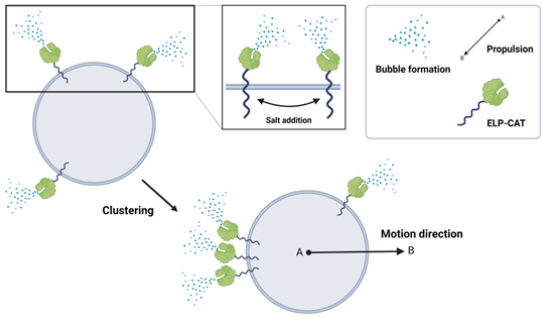

Figure 1. Graphical representation of the coacervate-based artificial cells, which are equipped with motor enzymes through the membrane incorporation of the ELPs. The dynamic custering of enzymes is visualized upon ammonium sulfate (salt) addition.

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ABSTRACT 41

FRET-sensing of multivalent protein binding at the interface of targeted biomimetic emulsion droplets decorated with amphiphilic tunable fluorescent ligands

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Cell adhesion is a fundamental phenomenon for cell communication and regulation [1]. Adhesion sites are triggered by the binding of single ligand-receptor pairs that will initiate the formation of clusters of receptors. To study cell adhesion in live cells with microscopy techniques, there is a need of adaptive and interactive fluorescent soft materials targeted towards membrane receptors with a signal sensitive to the binding and movement of receptors and ligands at the interface. We propose new biomimetic fluorescent O/W emulsion droplets for membrane receptor targeting and sensing [2,3]. The liquid microparticles are functionalized with tailor-made amphiphilic fluorescent ligands which are inserted at the interface of the emulsion droplets without covalent linkage. The micrometric droplets are targeted towards lectins or biotin membrane receptor. They can be specifically recognized and internalized by cells as evidenced by their phagocytosis in Primary murine bone-marrow derived macrophages. By using a FRET pair of fluorescent amphiphilic mannolipids, it was possible to detect the selective multivalent binding of concanavalin A in solution by energy transfer showing that the emulsion droplets can sense receptors binding at the interface and the associated movement of the ligands at the site of adhesion. Our results demonstrate that this biosensing platform can be internalized specifically by phagocytes, effectively mimicking a bacterium, and revealing multivalent binding of proteins, along with induced movement of ligands at the adhesion interface.

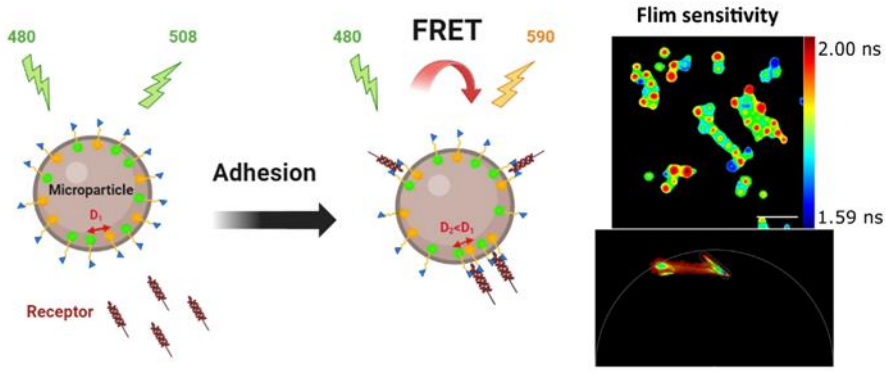

Figure 1. (A) Schematic representation of the droplets and of the use of FRET to visualize receptor engagement. (B) Typical FLIM images of the FRET donor with phasor representation of droplets simultaneously coated with a FRET pair of fluorescent amphiphilic mannolipids in presence of ConA. The fluorescence intensity and lifetimes measured are those of the donor: λexc = 488 nm, collection: 498 nm – 530 nm.

Acknowledgments: This work is supported by a collaborative grant between FN, JMM and JF (ANR-20-CE13-0017-01).

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ABSTRACT 42

Exploiting Cyclodextrin-Protein Interactions to Generate Dynamic Biomaterials from Human Amniotic Membrane

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Human amniotic membrane (AM) is a well-established resource in the field of tissue engineering. It has previously been employed in both experimental and clinical settings for the development of scaffolds that promote wound healing and tissue regeneration, due to its low immunogenicity, as well as the presence of bioactive molecules that grant it anti-inflammatory, anti-microbial and anti-scarring properties [1].

In this work, the complex biophysical properties of native ECM were reestablished in AM through cyclodextrin-mediated supramolecular assembly. As a protein-rich matrix, AM can participate in host-guest interactions with cyclodextrins, which form complexes with aromatic amino acids. Through a simple chemical modification, cyclodextrins can be functionalized with photocurable moieties, enabling the polymerization of the protein-cyclodextrin complexes [2] . Ultra-soft hydrogels with self-healing capabilities are rapidly formed through irradiation in the presence of a photoinitiator. The hydrogels emulate the typical mechanical behavior of the native ECM, displaying viscoelastic and strain-stiffening properties, which can be adjusted to modulate cell response. The structure and topography of the hydrogels is shown to be susceptible to remodeling through the application of chemical agents, such as competitive guest molecules, or mechanical stimuli, such as cell generated forces. Thus, this approach enables production of highly dynamic and adaptable hydrogels from AM.

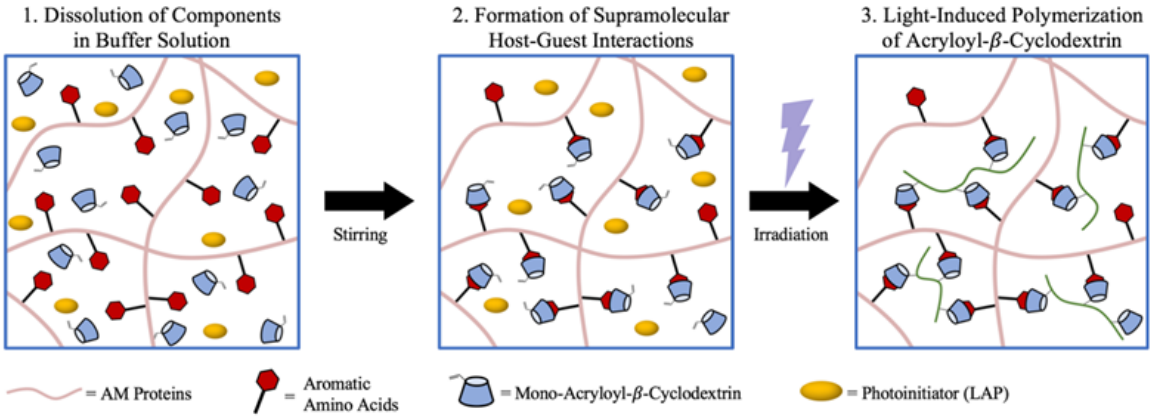

Figure 1. Assembly of dynamic AM-derived hydrogels through the photopolymerization of protein-cyclodextrin complexes.

Acknowledgments: This work was financed by ERC grant agreement ERC-2017-ADG-883370 (REBORN), by the EU's Horizon Europe research and innovation program under grant agreement No. 101079482 ("SUPRALIFE") and by FCT through the individual contract 2020.01647.CEECIND, the doctoral grant 2022.10626.BD and through project "TETRISSUE" (PTDC/BTM-MAT/3201/2020). This work was developed within the scope of project UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC).

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ABSTRACT 43

3D neuronal monitoring platforms for electrochemical sensing of neurotransmitters

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At the base of several neurological diseases (e.g., Alzheimer's disease, Parkinson's disease) there are neurotransmitters dysfunctions. Thus, determination of neurotransmission dynamics is a compelling phenotype to judge drug-induced neuroprotection [1]. This project aims to develop an electrochemical biosensor of 3D hybrid hydrogel based on extracellular matrix and functionalized carbon nanotubes (f-CNTs) that quantifies neurotransmitters concentration in 3D neuronal cell cultures (Figure 1).

As first step, this study presents a comprehensive investigation into the development of neuronal cultures with distinct neurotransmission phenotypes. Models were developed from induced pluripotent stem cells (iPSC) derived neurons [2] resulting in mature dopaminergic, cholinergic, and glutamatergic neurons with observable morphological traits and functional properties. Characterization included immunochemistry, multi-electrode array recordings, gene expression analysis (rt-PCR), and calcium imaging, demonstrating the maturation and phenotypic characteristics of these neurons. Additionally, the impact of carbon nanotubes (CNTs) on neuronal differentiation was examined, revealing improved cell adhesion and gene expression in the presence of CNTs.

In parallel, an electrochemical sensor platform was designed using Indium-Tin-Oxide (ITO)-coated coverslips with f-CNTs serving as working electrode. The CNTs were functionalized with gold nanoclusters (AuNCs) or cobalt phthalocyanine (CoPC) for dopamine and hydrogen peroxide detection, respectively. The CNT-Au sensor's [3] electrochemical performance was characterized by differential pulse voltammetry, demonstrating a noticeable limit of detection (LOD) of 150nM and a sensitivity of 3,98E-04 A cm^{-2} μM^{-1}. Overall, this study lays the foundation for the development of a 3D neuronal culture monitoring platform coupled to the iPSC derived neurons with potential applications in neuroscience research and drug discovery.

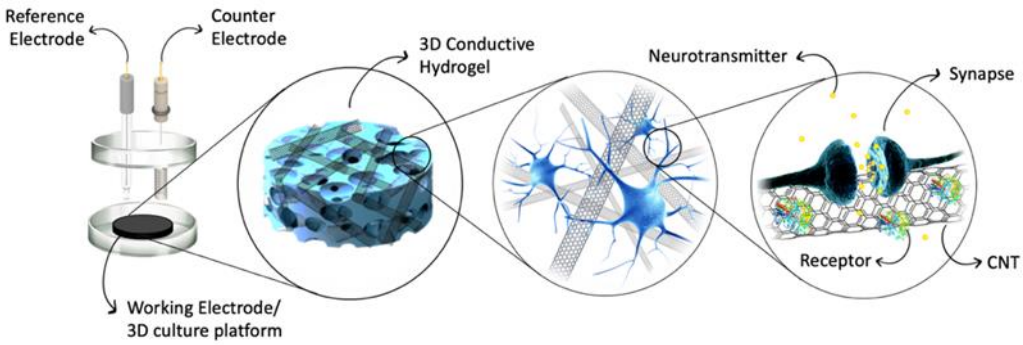

Figure 1. Design of 3D neural monitoring platform for neural network growth and synaptic activity monitoring.

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ABSTRACT 44

Squaramide-based supramolecular biomaterials

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Supramolecular materials show great potential to mimic the biopolymer networks of the natural extracellular matrix because of their filamentous structure and function [1]. Due to the non-covalent interactions that hold them together, these materials also demonstrate facile tunability preparation with tailorable compositions, environmental responsiveness, self-healing upon damage, and recyclability. Their straightforward processing permits the mixing of monomers functionalized with biomolecules such as peptides to tune cell behaviour and compatibility, and their responsiveness to different stimuli opens the door to designer materials with tunable properties that can be used to deliver therapeutic payloads or as scaffolds for tissue engineering [2][3]. To realize these end-stage applications, there is a need for structurally simple monomers that can be readily made and robustly self-assemble into polymeric architectures in the presence of complex molecular cargo. Squaramides, structurally minimal ditopic hydrogen-bonding units, show tremendous potential in this regard due to their high synthetic accessibility starting from commercially available precursors and capacity to engage in strong non-covalent interactions [1-3]. With this poster, I will communicate our exploration of the squaramide synthon as a building block for functional hydrogel materials for use in 3D cell culture.

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ABSTRACT 45

Self-Assembly of Metabolism Interfering Nanofibers inside Cancer Cells

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Supramolecular structures are omnipresent in nature and play crucial roles in the formation of hierarchical orders to maintain the function of a living system. Prominent examples for non-covalent hierarchical structures are the DNA double helix, quaternary structures of proteins or lipid-lipid interactions in cell membranes. Inspired by these systems, the self-assembly of small molecules into supramolecular structures promises a unique opportunity to create biological active structures with characteristic properties. The usage of monomers, without an own intrinsic function, that are able to self-assemble into functional supramolecular structures in a controlled manner has a high potential for novel therapeutic approaches. Peptide-based monomers are of specific interest, due to their easy synthesis and chemical modification, which can lead to a variety of supramolecular structures. We designed peptide precursors that undergo rearrangement when exposed to intracellular stimuli found in cancer cells, like increased GSH or H_2O_2 concentrations. Upon rearrangement, the peptides assemble into nanofibers, which interact with cellular structures and thereby inhibit the cell metabolism. The interference of glycolysis and oxidative phosphorylation results in a drop of ATP production and eventually in apoptosis. The controlled intracellular formation of supramolecular structures could offer a unique mechanism to affect cancer cell metabolism and could be a promising therapeutic approach.

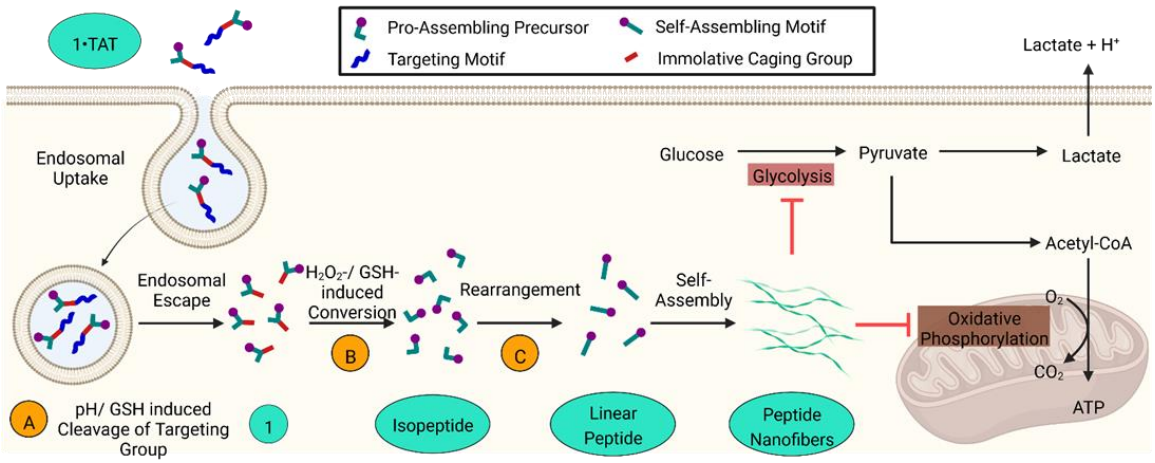

Figure 1. Schematic illustration of intracellular peptide nanofiber formation, induced by H_2O_2 or GSH. The supramolecular structures interact with cellular structures to interfere cell metabolism, eventually causing apoptosis.

Acknowledgments: The authors gratefully acknowledge financial support from the Max Planck-Bristol Centre for Minimal Biology, the Germany Research Foundation (DFG)–project number 213555243– SFB 1066 (B16) and project number–417590517-SFB 1415, and from the European Union's Horizon 2020 research and innovation program under grant agreement no. 881603 (GrapheneCore3).

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ABSTRACT 46

Spontaneous formation of solid shell multicompartments at all-aqueous interfaces

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Aqueous two-phase systems present themselves as suitable environments to mimic the organized compartmentalization seen in many biological entities, which exhibit delicate interfaces crucial for the exchange of important biomolecules. However, the production of said systems remains a challenge, mostly relying on complicated methodologies and the use of hazardous solvents. Herein, a high yield all-aqueous interfacial assembly method for the production of multicompartment capsules with a solid membrane is described. With polyelectrolyte complexation occurring at the interface, changes in both polyelectrolyte concentration and complexation times proved to be easily manipulated variables that enable the formation of distinct compartments. This mild processing technology also allows the encapsulation of animal cells, which were capable of invading capsule walls for specific processing conditions.

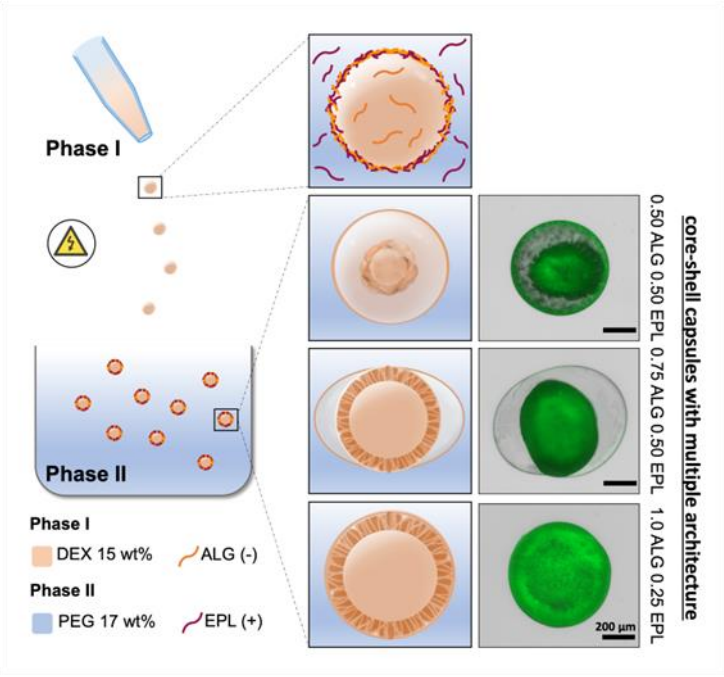

Figure 1. Schematic representation of an all-aqueous interfacial assembly for the production of robust uni- and multicompartment capsules.

Acknowledgments: This work was financially supported by the European Research Council grant agreement ERC-2019-ADG-883370 (project Reborn), by the Programa Operacional Competitividade e Internacionalização, in the component FEDER, and by national funds (OE) through FCT/MCTES, in the scope of "CellFi" (PTDC/BTM-ORG/3215/2020). This work was funded by the European Union's Horizon Europe research and innovation programme under the Grant Agreement No. 101079482 ("SUPRALIFE"). This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC). M.B.O acknowledges national funds through FCT – Fundação para a Ciência e a Tecnologia, I.P., under the Scientific Employment Stimulus - Institutional Call - CEECINST/00013/2021. FCT also financially supported this work through individual doctoral grant 2021.06131.BD of Francisca Gonçalves Perfeito.

ABSTRACT 47

Advanced Modelling of Tumor-Stroma Dynamics with Fine-Tuned Decellularized Matrix Hydrogels

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Aqueous Pancreatic ductal adenocarcinoma (PDAC) is one of the most lethal solid tumors due to its recognized resistance to anti-cancer therapies, which is attributed to the bioarchitecture of its tumor microenvironment (TME) [1]. Owing to the key role of the PDAC stroma in aggressiveness and resistance, innovative 3D *in vitro* bioengineering approaches have been sought. Recently, tissue-derived decellularized extracellular matrix (dECM) biomaterials have attracted considerable attention for the bioengineering of 3D human tumor platforms for their unique biomolecular cues that allow the modulation of increasingly physiomimetic properties [2].

Their ease of processing, mechanical tunability, and ability to support cell culture have generated particular interest in the development of preclinical platforms for the evaluation and validation of emerging therapeutics [3]. In this regard, we demonstrate here the establishment of an organotypic 3D *in vitro* model of pancreatic cancer by combining cancer cells and stromal fibroblasts with pancreatic tissue-specific dECM hydrogel and a photocrosslinking approach based on naturally occurring tyrosine residues in proteins to enable the screening of cellular and antibody-based immunotherapeutics. The dECM hydrogels exhibit self-gelling behavior, which greatly enhances the versatility of these platforms by allowing the modulation of tumor components, enabling a more accurate representation of pancreatic cancer hallmarks, even following its progression over time in the *in vitro* setting. This flexibility also extends to the ability of the dECM hydrogel to integrate different cell lines, opening the way for new studies in other human malignancies.

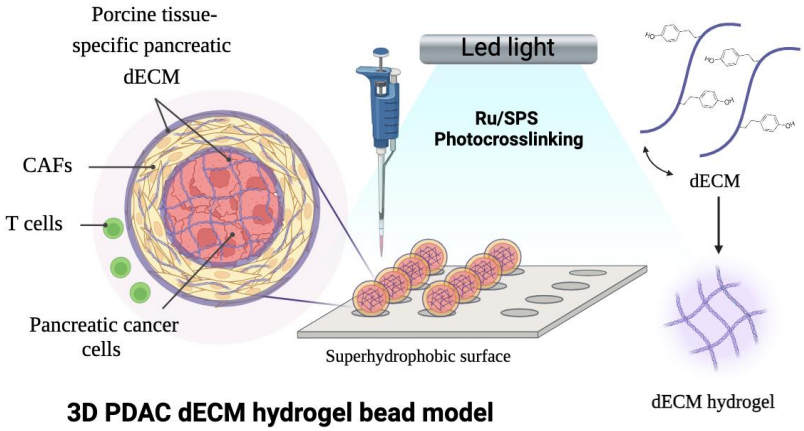

Figure 1. Schematic overview of the established 3D PDAC hydrogel bead model that reproduces key hallmarks of the tumorstroma axis in an in vitro setup that combines pancreatic cancer cells, cancer-associated fibroblasts, and tissue-specific dECM hydrogel. This model is used as a tumor proxy to screen T cell-based immunotherapies.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MEC (PIDDAC). The authors acknowledge the financial support by the FCT through Doctoral Grants (2023.03103.BDANA, M.H.P.).This work was funded by the European Union's Horizon Europe research and innovation programme under the Grant Agreement No. 101079482 ("SUPRALIFE"). This work was developed within the framework of EU INSPIRE project (grant ID: 101057777 a Cluster 1 - Health).

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ABSTRACT 48

Cellular Self-Assembled Innervated 3D Tumor Spheroids as Multi-Stratified Models for Therapeutics Screening

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Pancreatic adenocarcinoma (PDAC) is one of the cancers with the lowest survival rate and its incidence shows an increasing trend in recent years [1]. The complex tumor microenvironment (TME) of PDAC allows to build an extremely dense barrier that confers greater aggressiveness and resistance to therapies [2]. The importance given to the study of the cellular composition of the TME has increased, given its contribution to the malignancy of this cancer [3]. In this sense, evidence has emerged that neuronal cells, present in this TME, contribute for the proliferation, invasion and metastasis of cancer cells, essentially through signalling events triggered by the β2-adrenergic receptors [4]. However, most of the available data are derived from *in vitro* 2D and animal models, which do not allow to fully mimic PDAC pathophysiology. To overcome these challenges, in the last decade, 3D *in vitro* disease models have been developed. In this context, herein we describe the development of an innovative triple-layered spheroid models with the inclusion of the three crucial cell types to recapitulate the different stages of innervation in PDAC TME. The bioengineered models exhibit suitable cell viability in all the test conditions, increasing with the proximity of neuronal-like cells to PDAC cancer cells. The triple-layer compartmentalization was confirmed via tracking of reporter cells. This approach also enabled to evaluate cellular migration through the different layers of the engineered models. Overall, these newly designed models have potential to be used as pre-clinical platforms for screening new therapies targeting innervation or to discover new biomarkers in this neoplasia and others that exhibit perineural invasion phenomena.

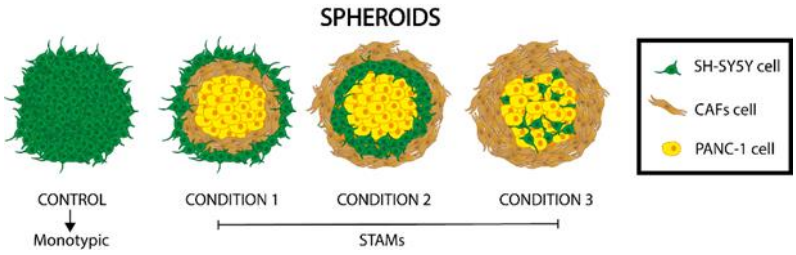

Figure 1. Schematic of bioengineered triple-layer spheroids construction and control model, using three cell lines (PANC-1, SH-SY5Y and CAFs) - monotypic SH-SY5Y spheroids (Control), triple-layer spheroids representing different innervation stages in PDAC patients- **Condition 1**: first layer with PANC-1 cells, second layer with CAFs cells and third layer with SH-SY5Y cells; **Condition 2**: first layer with PANC-1 cells, second layer with SH-SY5Y cells and third layer with CAFs cells; **Condition 3**: first layer with PANC-1 and SH-SY5Y cells and second layer with CAFs cells.

Acknowledgments: This work was developed within CICECO-Aveiro Institute of Materials projects, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through FCT/MEC (PIDDAC). The authors acknowledge financial support by the Portuguese Foundation for Science and Technology through Doctoral Grants (2023.03472.BDANA, M.T.C); DFA/BD/7692/2020, M.V.M) and an Assistant Researcher contract (CEECIN/02106/2022, V.M.G.). This work was funded by European Union's Horizon Europe research and innovation programme under the Grant Agreement No. 101079482 ("SUPRALIFE").

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ABSTRACT 49

Fabrication of Bicontinuous Microporous Hydrogels using Aqueous Emulsion Templating

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Bulk hydrogels, comprising nanoporous polymer networks, have hindered cell motility, interactions, and nutrient diffusion, limiting their efficacy in tissue engineering. To address these limitations, there has been a growing focus on interconnected microporous hydrogels. These scaffolds enhance nutrient diffusion, facilitate cellular motility, and support cell spreading, proliferation, and interactions, even allowing tissue ingrowth [1,2] . Existing manufacturing methods for such hydrogels often involve costly processes or employ cytotoxic porogens or leaching agents, compromising biocompatibility. Aqueous two-phase system (ATPS) enabled emulsion templating emerges as an alternative technique, offering simplicity and versatility. This method involves mixing a pre-gel with an immiscible aqueous porogen whose intermixing is thermodynamically unfavorable due to supramolecular interactions between the phases, forming an emulsion where the porogen phase is distributed volumetrically throughout the pre-gel. Despite allowing cell inclusion in the pre-gel solution, existing methodologies provide limited pore interconnectivity [1-3] . This project endeavors to develop a tunable bioprintable interconnected microporous GelMA-HAMA hydrogel bioink. Leveraging GelMA's capacity to form immiscible phases with Polyethylene-Oxide and Xanthan gum porogen solutions through ATPS, a novel mixing method was devised, enabling precise control over hydrogel microarchitecture, yielding high pore interconnectivity and porosities nearing 70%. The resulting bioinks were utilized to fabricate perfusable hydrogels, demonstrating favorable cell proliferation and biocompatibility.

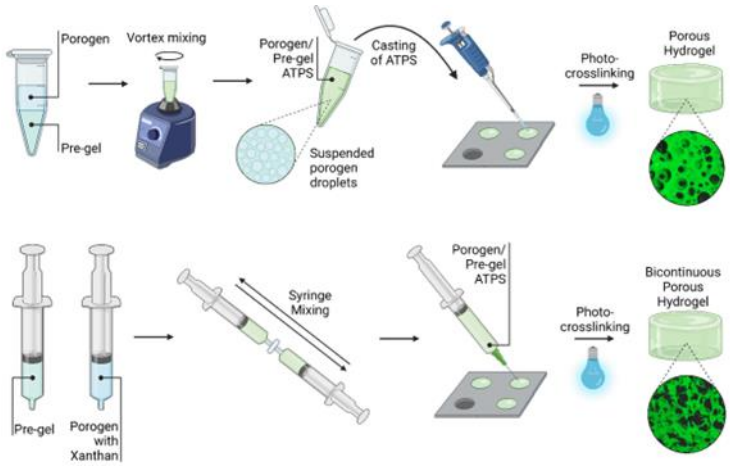

Figure 1. Schematic of the ATPS preparations used in this work. (Top) Production of unconnected porous hydrogels. (Bottom) Production of bicontinuous porous hydrogels.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC). This work was also funded by the European Union's Horizon Europe research and innovation program under the scope of SUPRALIFE project (Grant agreement 101079482).

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ABSTRACT 50

Cell-loaded fibrous scaffold and fibrous matrix-hydrogel systems for skin tissue engineering applications

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One of the three triads, scaffold, is crucial to tissue engineering because it acts as a temporary matrix to help cells regenerate and repair injured or missing tissues. These scaffolds promote cellular adhesion, proliferation, and differentiation in vitro and in vivo. Generally, the material used to develop these scaffolds should be highly biocompatible and unlikely to result in an initial or future foreign body reaction that could be identified clinically or immunologically. The material's ability to degrade and resorb at a controlled rate and the adhesion, proliferation, and expansion of the specific tissue cells implanted into the 3-D construct in terms of quantity (number of cells/per void volume) and quality are additional properties. In such cases, hydrogels come into the picture, where they provide the properties required for soft tissues, such as holding the moisture content, thus preventing drying out of the wound area, acting as a delivery system that can deliver the desired drugs, biomolecules or growth factors required for the repair of damaged tissue. The research highlights how a cell-loaded electrospun scaffold and fibrous matrix-hydrogel double-layered matrix have been explored for diabetic and burn wound healing applications, respectively. The fibrous scaffold and hydrogel thus prepared acted as a reservoir of cells and growth factors. Various properties of the scaffolds and hydrogel, such as the degradation, swelling ability, tensile strength, and rheological properties, were studied. The hydrogel was also loaded with VEGF165, which helped improve cell proliferation. The prepared scaffold and fibrous hydrogel matrices were tested in diabetic and burn wound healing animal models, the outcomes of which were evaluated by histopathology and immunohistochemistry. The research highlights the importance of biomaterial scaffold/hydrogel in cell and growth factor delivery to the wound site, which was instrumental in achieving improved tissue repair and regeneration.

ABSTRACT 51

Advancing the Treatment of Spinal Cord Injury through Multiplexed Supramolecular Peptide-Amphiphilic Hydrogels

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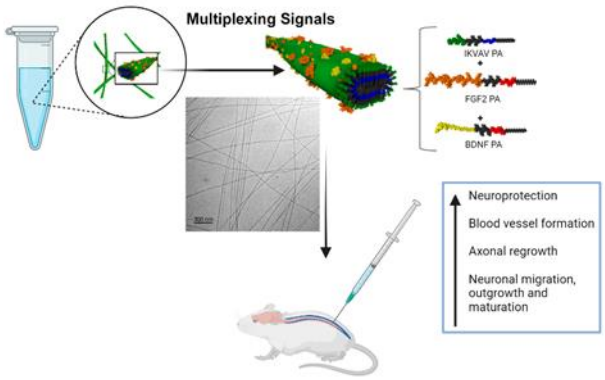
Each year, spinal cord injuries affect 250,000 to 500,000 people worldwide, resulting in a reduction in both quality of life and life expectancy [1]. Building on our previous groundbreaking research [2] in which a peptide amphiphile-based hydrogel containing laminin and fibroblast growth factor 2 (FGF2) mimetic signals significantly improved recovery in severely spinal cord injured mice, our focus shifted to the development of a multiplex peptide amphiphile hydrogel. This new hydrogel integrated FGF2, brain-derived neurotrophic factor (BDNF) and laminin (IKVAV) mimetic signals, which are recognized for their neuroprotective and regenerative properties in spinal cord injury repair [3]. FGF2 and BDNF mimetic peptide amphiphiles with a tuned β-sheet region (VVAA) were co-assembled with different IKVAV PAs, demonstrating different degrees of movement using simulations. Fiber formation was observed by cryo-transmission electron microscopy, and different degrees of β-sheet order were revealed by wide-angle X-ray analysis. However, reducing the percentatge of IKVAV and increasing FGF2 and BDNF peptide amphiphiles in the coassembly resulted in shortened fibers with reduced mechanical strength. As part of our ongoing efforts, we performed 2D and 3D in vitro assays to evaluate the bioactivity of these coassemblies on neuronal cells. Our goal is to identify the most bioactive combination for subsequent combinatorial approaches with cells in in vivo assays using severe spinal cord injury mouse model. Our research highlights the importance of designing biomimetic artificial extracellular matrices to authentically mimic the native spinal cord microenvironment to revert paralysis.



Acknowledgments: We are grateful to the following funding sources: FPI fellowship PRE2022-101803 (P.C) and Ramon y Cajal fellowship RYC2020-028732-I (Z.A), Grant PID2021-124839OA-I00 and CNS2022-135407 funded by MCIN/ AEI/10.13039/501100011033.

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ABSTRACT 52

Engineering Dynamic ATP-Based Coacervates via Peptide-Nucleotide Complex Coacervation

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Adenosine triphosphate (ATP) is used as a chemical signal in living cells for many processes, and as a molecular fuel [1]. This dual functionality is crucial and illustrated by ATP's involvement in actin filament formation. Actin filaments arise from ATP binding, inducing polymerization, while ATP hydrolysis, catalyzed by ATP-actin units, leads to depolymerization. Under specific conditions, polymerization and depolymerization create an intermediate out-of-equilibrium state until ATP is depleted.

Coacervates are micro-sized liquid-like droplets that lack of a physical membrane, formed via LLPS [2]. Many scientists believe that coacervates played a pivotal role during the origin of life, as protocells [3]. These membraneless structures selectively concentrate molecules, enhancing reactional rates through compartmentalization [2]. The design of ATP-based coacervates, allows for the design of functional and dynamic structures, which paves the way for engineering of out-of-equilibrium protocells [4].

In this work we report the formation of dynamic condensates through associative LLPS of the peptide sequence P29 (KDFLPSPQTAW) with ATP. After four days, a significant increase in inorganic phosphate (pi) concentration was observed, suggesting accelerated ATP hydrolysis. Surprisingly, the coacervates showed motility, and formed elongated structures after 4 days. We hypothesize that the observed motion is due the energy released during ATP hydrolysis, and the emergence of elongated structures is attributable to the ATP responsiveness of these coacervates. This study opens avenues for the creation of complex systems with diverse functionalities, offering potential in the development of novel peptide-nucleotide compartments.

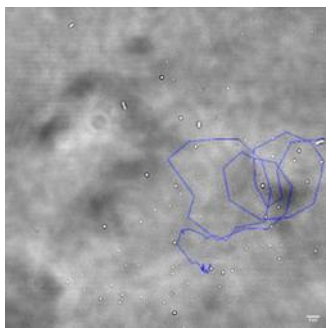

Figure 1. Brightfield microscopy and tracking of the movement of an individual coacervate on the third day of experiment with the sample 5mM ATP: 15mM P29 in a scale of 5µm. In blue is the line with the course taken by the coacervate made with the tracking tool from the ImageJ program.

Acknowledgments: This work was supported by FCT – Fundação para a Ciência e a Tecnologia, I.P., through MOSTMICRO-ITQB R&D Unit (UIDB/04612/2020, UIDP/04612/2020) and LS4FUTURE Associated Laboratory (LA/P/0087/2020) “.

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ABSTRACT 53

Investigating Amino Acid Enrichments and Patterns: Understanding Biases in Liquid-Liquid Phase Separation

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Biological compartmentalization forms membraneless organelles, also known as condensates, through liquid-liquid phase separation (LLPS). This process is driven by nucleic acids and intrinsically disordered proteins (IDPs) and is known to enhance biochemical efficiency and organization [1,2]. The stickers and spacers model explains LLPS, where aromatic amino acids (stickers) drive it, and polar residues (spacers) provide flexibility to the protein, while also relying on the multivalence, patterning, and charge distribution of amino acids to initiate phase separation [1-5].

. Our research analyses amino acid enrichment in 198 IDPs across functional families. Droplet Promoting Regions (DPRs) show significant enrichment of Glycine (G), Serine (S), Proline (P), and Alanine (A). Enriched polar amino acids promote disorder in IDPs, while aromatic and charged residues confer multivalent properties. Family-specific variations include 56% polar residues in RNA-binding vs. 36% in chromatin-binding proteins, highlighting the context dependency in protein function.

DPR examination reveals repeating triple motifs (e.g., GRG, PAP, SAS), charged doubles (DD, KK) and clusters (e.g., GGG, PPP). Rare motifs (YSPTSPSY, YGGDRGG, YGQQSS) perfectly repeat along DPR sequences, emphasizing LLPS relevance. Experimental validation with peptides containing the discovered motifs showed the formation of biomolecular condensate under physiological conditions.

Our research aims for a comprehensive understanding of sequence disorder's role in LLPS, unraveling chemical principles governing this phenomenon. This knowledge carries profound implications for controlling and harnessing LLPS, applicable in drug discovery and biocatalysis.

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ABSTRACT 54

From Code to Structure: Molecular Modeling in Biomaterials Assembly

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Molecular modeling and simulations of biomolecules has been growing in the last decades thanks to software optimization and rapid hardware improvements. Atomistic and coarse-grained molecular dynamics (MD) simulations of proteins have become more accessible, user-friendly, and implemented in many protein research projects.

The usage of current atomistic and coarse-grained force fields and MD software can be employed in the study of peptide and protein self-assemble and structural stability. Here, examples of computational studies of monomeric and assembled peptides and proteins are presented: i) the conformation changes of a designed tripeptide in monomeric and assembled states; ii) a structural model of the assembly of a reflectin-based peptide [1]; iii) a phosphotyrosine-binding oligopeptide conformational analysis computational alanine scanning [2]; iv) coarse-grained simulation of reflectins' aggregation in different protonation states.

The presented examples demonstrate multiple unique capabilities of molecular modeling techniques applied to the study of biomaterials. Through atomistic and coarse-grained MD it is possible to enrich research strategies in biomaterials by predicting geometric and physico-chemical properties, crucial for understanding the mechanisms and material characteristics obtained from wet-lab experiments.

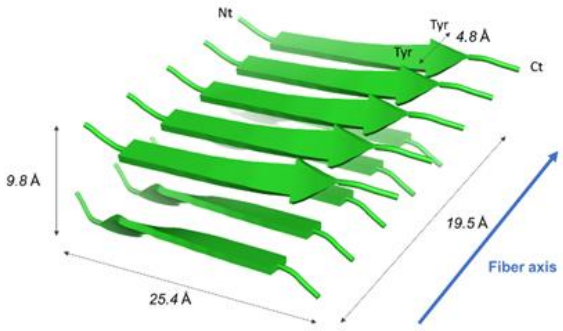

Figure 1. Structural model of "ii)": the assembly of a reflectin-based peptide, adapted from [1].

Acknowledgments: F.C.T. (Portugal) for projects PTDC/BII-BIO/28878/2017, 2022.15912.CPCA.A1, PTDC/CTM-CTM/3389/2021, Research Unit – UCIBIO (UIDP/04378/2020, UIDB/04378/2020), Associate Laboratory– i4HB (LA/P/0140/2020), the ERC under the EU Horizon 2020 research and innovation programme (SCENT-ERC-2014-STG-639123, 2015–2022 and 101069405-ENSURE-ERC-2022-POC1). FCT/MEC for C.E. contract CEECIND/07088/2022 and fellowships SFRH/BD/147388/2019 for I.L., 2022.11305.BD for C.S.

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ABSTRACT 55

Peptide ionogels in designed solvents

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Ionogels bear tunability, non-volatility, high ionic conductivity and good thermal, chemical and electrochemical stability [1,2]. The molecular self-assembly mechanisms of biomolecules in ionic liquids are complex and still poorly understood, as ionic liquids themselves present self-assembling properties. The versatility of the ionic liquids can be tailor-made in relation to the properties of gelator molecules, leading to rationally designed structured materials [3]. In this work, we designed tripeptide ionogels, previously shown to self-assemble in aqueous solvent [4]. Inspired by the peptide's self-assembly propensity in aqueous environments, we designed an ionic liquid solvent that could facilitate the formation of ionogel. The tripeptide ionogels presented unique properties not shown in the corresponding hydrogels, namely high air-stability and ionic conductivity, which were explored as gas sensitive layers in electronic noses. We show the potential of tripeptide ionogels to act as humidity sensors and to discriminate at the single carbon alcohol level and between twelve volatile organic compounds under environmental conditions. This new class of stable conductive soft biomaterials unlocks a wide range of applications within biological, medical and industrial fields.

Acknowledgments: The authors acknowledge funding from the European Research Council under the EU Horizon 2020 research and innovation programme (SCENT-ERC-2014-STG-639123, 2015–2022 and 101069405-ENSURE-ERC-2022-POC1) and from FCT in the scope of the project UIDP/04378/2020 and UIDB/04378/2020 of the Research Unit on Applied Molecular Biosciences – UCIBIO and the project LA/P/0140/2020 of the Associate Laboratory Institute for Health and Bioeconomy – i4HB. CE thanks FCT (SFRH/113112/2015 and CEECIND/07088/2022).

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ABSTRACT 56

On the communication between nuclei and mitochondria in a hydrogel environment

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Neurological and cancer diseases share a common character: dysfunctional mitochondria. With the onset of this condition, these organelles send a retrograde signal back to the cell nuclei, potentially affecting gene expression. This process is termed mitochondria retrograde signaling. However, our understanding of this pathway and its downstream effects remains limited due to the complexity of mammalian cellular signaling networks [1,2].

To address this challenge, we aim to develop a minimal cell model as an in vitro platform for investigating mitochondria retrograde signaling by isolating and encapsulating nuclei and mitochondria from HeLa cells in hydrogel networks.

The initial steps of our study involve the purification of nuclei and mitochondria from HeLa cells. Subsequently, we evaluate the functionality of these organelles placed outside their host cells, both in bulk, individually encapsulated within hydrogels, and co-encapsulated into PEG-based hydrogels. We examine the mRNA production and the retention of stimulated inflammatory markers (TNF-α and IL-1B) in purified nuclei. Meanwhile, the core property examined for mitochondria is ATP production. We also consider the influence of spatial distribution by encapsulating the organelles within distinct hydrogel structures, including a random mix and a compartmentalized configuration.

In summary, our ongoing efforts represent the initial steps towards developing a minimal cell model that can be employed to unravel the pathways associated with mitochondria retrograde signaling.

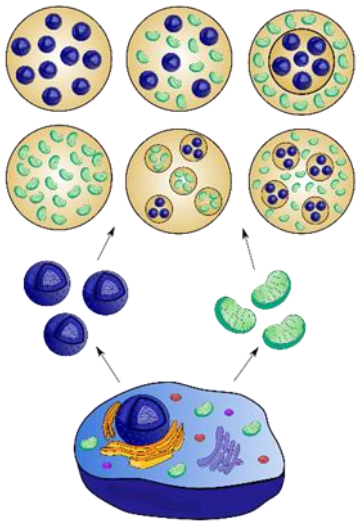

Figure 1. A minimal cell is created by isolating nuclei and mitochondria from donor cells and encapsulating them into distinct hydrogel networks.

Acknowledgments: I would like to acknowledge Brigitte Städler and the laboratory for cell mimicry for support, collaboration, and a good working environment. Furthermore, I would like to thank the Human Frontiers in Science project for the funding and my friends and family for support.

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ABSTRACT 57

Exotic water structure and dynamics in peptide nanochannels

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Physical and chemical properties of water confined in nanochannels essentially differ from a macroscopic bulk state. Most studies deal with water within hydrophobic carbon nanotubes. In contrast, ionic functional groups at the nanochannels made of organic species, such as peptides, dictate water the spatial organization and the behavior, thus biasing its properties. Therefore, the study of such systems is of great fundamental and practical importance.

In this work, we analyze the structure and dynamic behavior of water confined in the nanochannels with the pore size below 1 nm made of dipeptides dileucine (Leu-Leu, LL), alanine-valine (Ala-Val, AV), tryptophan-glycine (Trp-Gly, WG), and diphenylalanine (Phe-Phe, FF). Depending on the peptide shell configuration and the pore size, single-crystal X-ray diffraction revealed the linear chains, single and double spirals of water molecules. The analysis of 2H solid-state nuclear magnetic resonance (ss-NMR) spectra show the presence of several types of crystallographically inequivalent water molecules in the nanochannels, and spin-spin relaxation times allow characterization of their dynamics and the mode of diffusion. Direct dynamic vapor sorption (DVS) measurements are used to derive the self-diffusion coefficients for different types of water. A phase transition of water to the supercritical solid-liquid state is detected.

The obtained results demonstrate a great potential for peptide nanotubes usage for the transportation of water and other small molecules in various micro- and nanofluidic devices.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020, and LA/P/0006/2020, and the project UniRCell (SAICTPAC/0032/2015, POCI-01-0145-FEEDER-016422) financed by national funds through the FCT/MEC (PIDDAC). NMR spectrometers are part of the National NMR Network (PTNMR) and are partially supported by the Infrastructure Project 022161 (cofinanced by FEDER through COMPETE 2020, POCI and PORL and FCT through PIDDAC). This work has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (Grant Agreement 865974). The authors are also grateful for the financial support granted by Agenda and Resilience Plan (PRR) and by the Next Generation European Funds to University of Aveiro, through the Agenda for Business Innovation "NGS – Next Generation Storage" (Project n°2, application C05-i01.01/2022). SK and AK were supported by FCT through the project "BioPiezoSensor" (2022.03781.PTDC).

ABSTRACT 58

Coarse-grain computer simulation approach to unveil interactions between phospholipid membranes and drug nanocarriers

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Physical Improving the efficiency of drug of nanocarriers is one of the main challenges in nanomedicine [1]. Nevertheless, nanotechnology is still a small portion in the pharmaceutical industry and only small companies and start-ups are the primary developers [2]. Reliable force fields and enhanced computational resources, opened the door to delve deeper into this topic [3]. This work presents a novel computer model based on the MARTINI, to characterise the interactions between phospholipid membranes, drugs and their nanocarriers. Two biological phospholipid membranes were selected, the 1-palmitoyl-2-oleoyl-glycero-3-phosphocholine POPC + 1-palmitoyl-2-oleoyl POPG (4-POPC:1-POPG) that resembles tumoral cell walls and the dipalmitoyl phosphatidylcholine (DPPC), related to the infection of adenocarcinoma human alveolar lung tissue cells. Two types of antitumoral drugs were considered, Doxorubicin (DOX) and Gemcitabine (GEM). DOX is used in many treatments such as leukaemia, lymphomas, breast, lung, cervical or head tumours. GEM is applied on testicular, breast, ovarian, lung, pancreatic and, bladder cancers. Two drug nanocarriers were chosen, the 5th generation of poly(amidoamine) dendrimer (G5 PAMAM)- a highly branched macromolecule composed by diamino alkyl core and four dendron protruded arms- and two nonionic Pluronic, P123 and F68, formed by grouping hydrophilic poly(ethylene oxide) (PEO) and hydrophobic poly(propylene oxide) (PPO) blocks. G5 PAMAM dendrimers are used in gene therapy, protein-receptors, catalysts, imaging agents or drug delivering. P123 and F68 are thermo-response Pluronic exhibiting diverse amphiphilic characters depending on the PPO/PEO content and they are adequate due to the relatively short storage time in blood stream. Based on validated parameters, coarse-grain molecular dynamics simulations (CG-MD) were performed to address each phospholipid membrane in aqueous solution in contact with preloaded nanocarriers at two drug-loading capacities under physiological conditions. **Figure 1** summarises preliminary results for the 4-POPC:1-POPG membrane and four nanocarriers loaded with DOX. **Figures 1a-d** shows the G5 dendrimer (maroon), the P123 micelle (PPO and PEO groups in black and orange, respectively), F68 micelle (PPO and PEO groups in blue and red, respectively) and, the P123&F68 micelle (ratio 1:1), respectively. DOX was partially released when using G5 dendrimers or P123 micelles, but it was retained when F68 is present (Figures 1c-d). Our CG-MD simulations show the intricate scenario between negatively charged 4-POPC:1-POPG and neutral DPPC membranes with a preloaded cationic G5 dendrimers or nonionic P123, F68 (and their mixture) preloaded micelles as nanocarriers, providing some clues regarding the impact of the charge and nature of the systems in the loading/release capacities of the analysed nanocarriers.

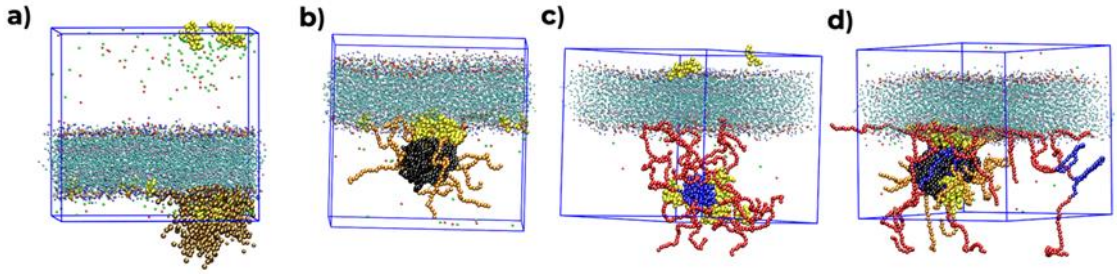

Figure 1. MD-CG simulation snapshots for POPG-POPC membrane (beads in cyan) in contact with a) G5 PAMAM dendrimer, b) P123 micelle, c) F68 micelle and d) P123&F68 micelle, all of them loaded with DOX (yellow). Water was removed for clarity.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MEC (PIDDAC). GPS acknowledges national funds (OE), through FCT in the scope of the framework contract foreseen n° 4, 5 and 6 of the article 23 of the Decree-Law 57/2016 of August 29th, changed by Law 57/2017 of July 19th. Simulations were financed by "Concurso de Projetos de Computação Avançada 3ª Edição" ref. CPCA/A2/15575/2022 and performed at OBLIVION UEvora ref. POCI-01-0145-FEDER-022217.

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ABSTRACT 59

From 2D to 3D: cholesterol decoys to deceive *Helicobacter pylori*

#A. S. Pinho [1,2,3], R. Pereira [1,2,4], M. G. Pereira [1,2], A. Rai [5], L. Ferreira [5,6], M. C. L. Martins [1,2,3], P. Parreira [1,2]*

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Antibiotic-based therapy to treat *Helicobacter pylori(Hp)* infection, the etiological agent of several gastric ailments & gastric cancer, fails in up to 40% of patients, mainly due to antibiotic resistance [1]. Data show the need to develop new strategies. *Hp* is auxotrophic for cholesterol(Chol) & its membrane incorporation is key to establish a successful infection & evade host immune response [2]. Here we describe proof-of-concept studies using 2D & 3D models to validate the use of surface-grafted Chol as a new bioengineered strategy for the management of *Hp* -gastric infection.

Different proportions (0, 12.5, 25, 50 & 100%) of Chol-poly(ethylene glycol)75Thiol/Sulfhydryl(Chol-PEG) & 1-mercapto-11-undecyl tetra(ethylene glycol)(EG4) were used to produce 2D self-assembled monolayers on gold surfaces (Chol-SAMs). Chol-SAMs were characterized as described in [3]. *Hp* J99 strain (highly pathogenic) adhesion to Chol-SAMs was determined by fluorescence microscopy (BacLight™Kit) & 25% Chol-SAMs was the best ratio (concentration-dependent).

3D gold nanoparticles were prepared as in [4], functionalized with Chol(Chol-NP) & characterized as described [4]. *In vitro* antibacterial assays using *Hp* J99 strain determined the Chol-NP minimum bactericidal concentration as 125 µg/mL, while control-NP (w/o Chol) required >500 µg/mL. After 2h, Chol-NP killed *Hp* through internalization & membrane rupture (Transmission Electron Microscopy). Chol-NP did not interfere with gut microbiota bacteria (*Escherichia coli* ATCC®25922, *Lactobacillus acidophilus*-01), were nonhemolytic & cytocompatible against human gastric adenocarcinoma cell line.

This study supports further development of Chol-based biomaterials to fight *Hp* infection.

Acknowledgments: A. S. Pinho would like to thank FCT for the PhD Studentship 2022.12580.BD and the ICBAS Doctoral Program in Biomedical Sciences. P. Parreira would like to thank FCT for CEECIND/01210/2018. L. Ferreira would like to thank BioRobotBeads (POCI-01-0247-FEDER-047081) project funded by European Regional Development Fund through PT2020.

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ABSTRACT 60

Enzyme-Induced Formation of Nanostructures within Living Cells

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Self-assembled superstructures, such as fibrils, play a crucial role in various biological processes, serving as fundamental components in cellular functions [1]. The primary focus of research on synthetic nanostructures within living cells has been the exploration of supramolecular drugs and imaging agents [2]. In particular, there has been a high effort to disrupt cellular processes through intracellular self-assembly to facilitate the development of innovative therapeutic applications [3]. Concurrently, the field of bottom-up synthetic biology has shown a growing interest in the creation of non-natural and non-toxic structures within cells, aiming to facilitate cell-material interactions with broader implications beyond triggering cell death. The intricate challenge lies in developing intracellular nanostructures that have minimal impact on cell viability due to the delicate balance and susceptibility to external perturbations.

This study presents a bioresponsive approach to the development of non-toxic peptide nanostructures within living cells, achieved through a precisely coordinated intracellular reaction cascade. The method employs a peptide-based assembly precursor that can undergo in-situ transformation into a self-assembling monomer through the enzymatic conversion triggered by the Golgi-associated protease, furin. Visualization of the formation and spatial distribution of the synthetic structures within the cell is achieved using confocal laser scanning microscopy. Furthermore, an assessment of cell viability in response to the peptide assemblies is conducted using cytotoxicity assays.

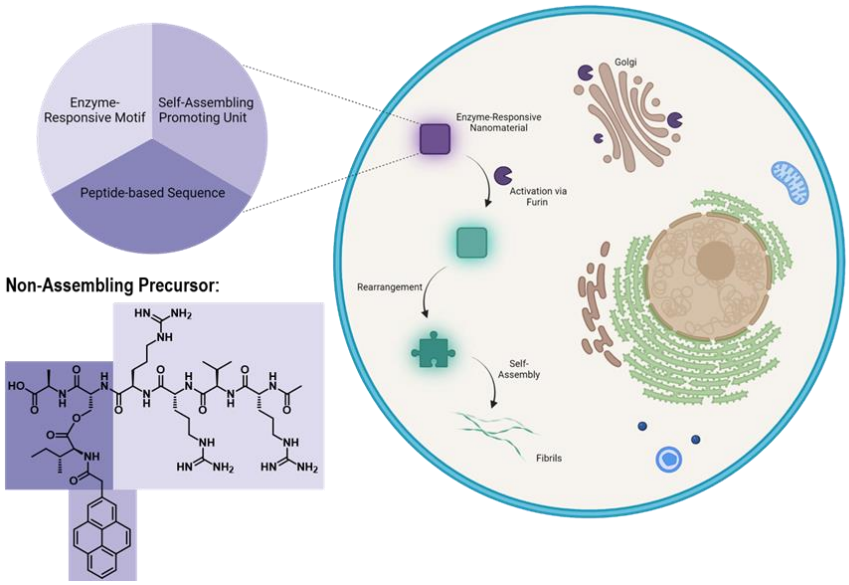

Figure 1. Schematic representation of enzyme-induced intracellular fiber formation. The peptide-based assembly precursor is composed of a furin recognition motif (RVRR) and a self-assembling-promoting pyrene unit, ensuring the fluorescence of the nanomaterial. Upon cellular uptake, the precursor undergoes cleavage by the Golgi-associated enzyme furin. Subsequently, linearization of the peptide leads to the formation of non-toxic fibrils within the cellular environment.

Acknowledgments: We gratefully acknowledge financial support from the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – (SFB1551 R04).

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ABSTRACT 61

Isolation and characterization of a reflectin protein from the common octopus

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Cephalopods have developed the ability to rapidly change their skin color and, in some cases, even the skin texture for the purposes of camouflage and, most importantly, communication. This adaptive feature is enabled by unique microanatomical and pigment chemistry-associated mechanisms [1]. In these animals, reflectins, mainly described in cuttlefish and squid, are a family of proteins found in iridocytes that play a key role in modulating structural color by polymerizing and forming light reflecting structures, making them high-value subjects for biobased material research furthering the interest of cephalopod research in the biotechnological field [2,3]. In the present work we aimed as investigating reflectins from octopuses. The skin of the common octopus (*Octopus vulgaris*) was described via light microscopy and transmission electron microscopy to pinpoint the structure and location of iridocytes, which are positioned beneath the pigment layer, as expected. We found reflectins in the skin of the common octopus and were able to derive full coding sequence of one reflectin variant by combining polymerase chain reaction (PCR) methods and Sanger sequencing. The isolated reflectin was successfully expressed in *E. coli*, purified [4] and characterized. Altogether, our findings enabled a research pipeline towards the isolation and expression of recombinant reflectin discovered in cephalopods, thus showing the potential of these animals as a relevant source of safe and environmentally friendly materials for biotechnological purposes.

Acknowledgments: This work has received funding from Fundação para a Ciência e Tecnologia (FCT, Portugal) for projects PTDC/BII-BIO/28878/2017, PTDC/CTM-CTM/3389/2021, and Research Unit on Applied Molecular Biosciences – UCIBIO (UIDP/04378/2020 and UIDB/04378/2020) and Associate Laboratory Institute for Health and Bioeconomy – i4HB (LA/P/0140/2020). The authors thank FCT for the research fellowship UI/BD/151154/2021 for IP. The authors are also thankful to Pedro Henriques for his assistance in sample preparation for EM.

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ABSTRACT 62

Photoresponsive covalently linked dextran networks – towards functional hydrogels

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Functional materials that can take up and release guest molecules upon stimulation with light can find applications in the area of targeted drug release [1]. Such systems are often based on azobenzene, a molecular photoswitch that can be photoisomerized between its cis and trans isomers [2]. The bacterial polysaccharide dextran and its modifications have been used in a wide variety of drug delivery systems [3].

Here a previously unreported doubly-covalent ester link by azobenzene moieties opens the way for a photo-triggered porous device for the release and capture of small molecules. We have been exploring the potential of such materials by varying the degree and fashion of crosslinking. The preparations of photochromic "functional" hydrogels *via* this procedure has been demonstrated.

Control experiments indicate remarkably different material properties when the azobenzene linker is attached by one or two covalent bonds. We have been following the kinetics of trans↔cis isomerizations of the azo-moiety and the micro- and macroscopic properties of the crosslinked dextran network using a wide variety of analytical techniques, including time-resolved UV/VIS spectroscopy, NMR spectroscopy and rheological measurements.

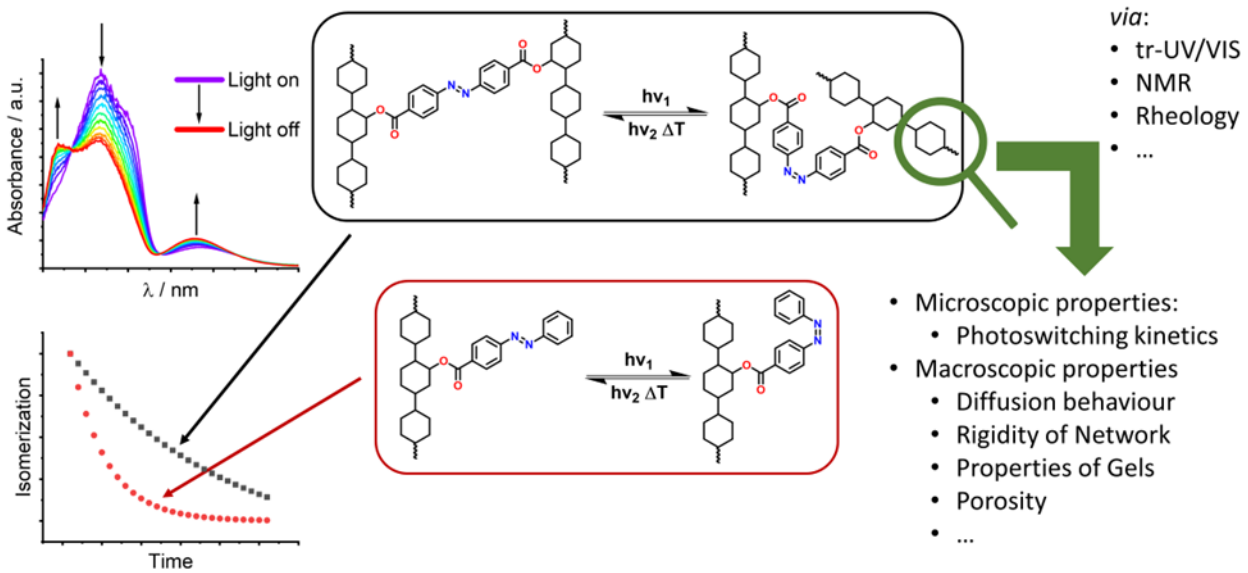

Figure 1. Azobenzene-crosslinked dextran molecules show photoswitching activity, paving the way towards photo-triggered catch-and-release devices.

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ABSTRACT 63

Towards developing bacterial adhesion inhibitors using arylamide foldamers as glycoptotein mimics

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The WHO has placed antimicrobial resistance among the top ten global public health threats [1]. Antivirulence agents promise to circumvent resistance by disarming the pathogen as opposed to affecting growth or viability [2]. A common strategy consists in interfering with adhesion, which is mediated by proteins that bind multiple carbohydrates displayed on the host cell surface [3]. To inhibit such interactions, many molecular scaffolds have been devised for the multivalent presentation of carbohydrates [4]. However, few allow a precise control of number, orientation, and distance between the sugars, which is fundamental to maximize biological activity.

Arylamide foldamers are bioinspired synthetic oligomers that, like peptides or nucleic acids, fold into well-defined conformations [5]. They feature key properties which make them ideal to build materials for multivalent presentation of carbohydrates: they adopt stable helical conformations in solution, whose predictability, tunability, and ease of synthesis render them particularly suitable to allow precise control of number, nature, and orientation of carbohydrate ligands. In addition, they can feature proteinogenic side chains to mimic protein surfaces.

Herein we describe our current efforts towards developing arylamide glycofoldamers as mimics of naturally occurring glycoproteins that decorate host cell surfaces, aiming to competitively interfere with the recognition processes that takes place between host cells and pathogens.

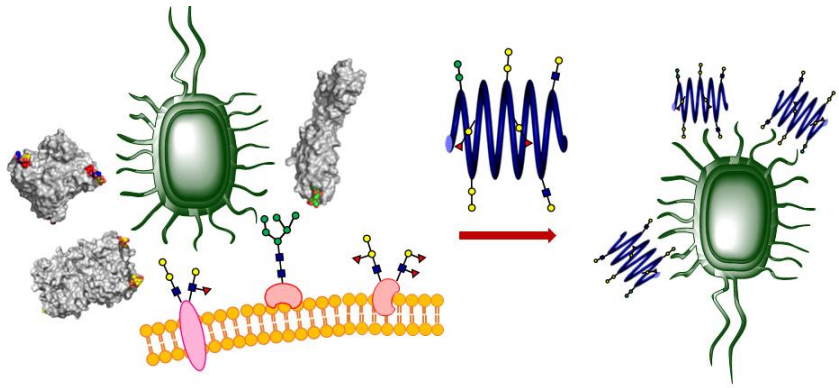

Figure 1. Blocking bacterial adhesion by arylamide glycofoldamers.

Acknowledgments: This work is supported by FCT - Fundação para a Ciência e a Tecnologia, I.P., through MOSTMICRO-ITQB R&D Unit (UIDB/04612/2020, UIDP/04612/2020), LS4FUTURE Associated Laboratory (LA/P/0087/2020) and project 2022.03561.PTDC. The latter supported F.S., F.K. and M.S. through fellowships. S.R. was supported by the Erasmus+ programme of the European Union. P.M. acknowledges FCT for research contract 2021.02532.CEECIND. The National NMR Facility is supported by CERMAX through Project 022162.

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ABSTRACT 64

Gold nanocluster-integrated albumin scaffolds: a traceable, xeno-free and customizable template for autogenic regenerative applications

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Albumin has attracted interest in the field of tissue engineering and regenerative medicine for preparation of three-dimensional scaffolds due to its stability, unique ligand-binding property, biocompatibility, high solubility and low cost [1]. In this study, a biocompatible, biodegradable, and fluorescent scaffold with an interconnected macroporous structure using human serum albumin (HSA), HSA-capped gold nanoclusters (HAS/AuNCs) and oxidized dextran was developed (Figure 1) and its morphological, structural, mechanical and physical properties were evaluated using FTIR, SEM, thermogravimetric analysis, swelling, compression, in vitro biocompatibility and degradation tests. Traceability of HSA/AuNC scaffolds was demonstrated via fluorescence imaging. Au release from scaffolds was evaluated using inductively coupled plasma-optical emission spectroscopy. The adhesion and proliferation of stem cells on scaffolds were assessed by alamarBlue assay for over a week. The ALP activity of cells was followed for up to 3 weeks. The findings demonstrated that the fluorescent HSA/AuNC scaffolds exhibited good in vitro biocompatibility and were biodegradable. Besides, the nanocomposite scaffolds ensured a convenient environment for cells to attach, expand and sustain metabolic activity [2]. This study demonstrates the potential of albumin-based engineered scaffolds containing bioactive agents that can be conjugated to the albumin backbone.

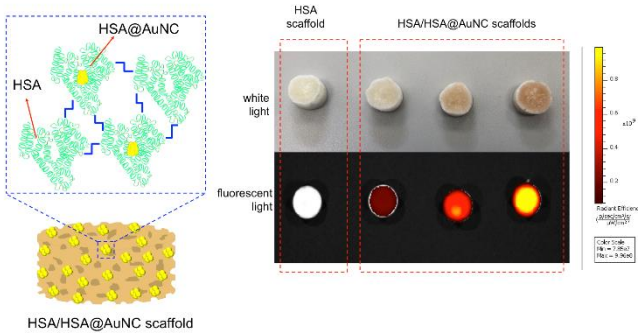

Figure 1. . Human serum albumin-based scaffold with fluorescence. In addition to being the main component of the construct, albumin has served as a stabilizing agent in the synthesis of gold nanoclusters (HSA@AuNC) in the scaffold. HSA@AuNC were incorporated into HSA constructs to impart the fluorescence property.

Keywords: Albumin-gold nanocomposites, Albumin-capped gold nanoclusters, Green synthesis of nanoparticles, Tissue engineering

Acknowledgements: This work was financially supported by The Scientific and Technological Research Council of Turkey (TÜBİTAK) [Grant Number 121M777].

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SOFT TRANSFERABLE SKILLS TRAINING PROGRAM

13rd March

Auditorium Renato Araújo – Central and Rectorate Building

8:00 - 8:30 **Registration**

8:30 - 9:00 **Welcome and Opening Remarks**

Artur Silva (Vice-Rector for Research, Innovation and 3rd Cycle of the University of Aveiro, Portugal)

João Borges, Alexandra Monteiro, Ana Soares, Daniela Ribeiro, Joana Pereira,Helena Vieira, Luísa Sal (University of Aveiro, Portugal)

Career Routes

Chairs: Ole Nielsen (University of Copenhagen, Denmark)

9:00 - 10:30 **E.W. "Bert" Meijer** (Eindhoven University of Technology, the Netherlands)
A personal journey through my chiral world
Béatrice Adelizzi (DNA Script, France)
The exercise of steering your career
Helena Vieira (University of Aveiro, Portugal)
Can scientists become entrepreneurial politicians?

10:30 - 11:00 **Coffee Break**

Scientific Publishing & Ethics

Chairs: João Borges (University of Aveiro, Portugal)

11:00 - 12:30 **E.W. "Bert" Meijer** (Eindhoven University of Technology, the Netherlands; Associate Editor of JACS)

Sébastien Lecommandoux (University of Bordeaux, France; Editor-in-Chief of Biomacromolecules**)**

Publishing your science in scientific journals: JACS and Biomacromolecules as examples

12:30 - 14:30 **Lunch Break**

Mental Health Basics and Imposter Phenomenon in Academia

Chairs: Daniela Ribeiro (University of Aveiro, Portugal)

14:30 - 16:00 **Olya Vvendenskaya** (Dragonfly Mental Health)
Mental health basics and imposter phenomenon in academia

16:00 – 16:30 **Coffee Break**

Career Development

Chairs: Rita Ferreira (University of Aveiro, Portugal)

16:30 – 18:00 **Paula Perez** (Institute for Research and Innovation in Health – i3S, University of Porto, Portugal)

Navigating career development: carfting your path in academia and industry

14th March

Auditorium Renato Araújo – Central and Rectorate Building

8:00 – 9:00 **Registration**

Diversity, Equity and Inclusion

Chairs: Luísa Sal (University of Aveiro, Portugal)

09:00 - 10:30 **Alejandra Palermo** (The Royal Society of Chemistry, United Kingdom)

Diversity, equity and inclusion in science

10:30 - 11:00 **Coffee Break**

Open Science

Chairs:Joana Pereira (University of Aveiro, Portugal)

11:00 - 12:30 **Antónia Correia** (University of Minho, Portugal)

Open science as a pillar of responsible research

Diana Silva (University of Aveiro, Portugal)

UA open science tools and services: FCT transformative agreements, institutional repository and data repository

13:00 - 14:00 **Lunch Break**

Data Management

Chairs:Vera Fernandes (University of Aveiro, Portugal)

14:30 – 16:00 **Julian Dederke** (ETH Zürich, Switzerland)

Data management: an introduction to good practice in handling your research data

16:00 - 16:30 **Coffee Break**

Project Management

Chairs:Alexandra Monteiro (University of Aveiro, Portugal)

16:30 – 18:00 **Bart Jansen** (Netherlands Organisation for Applied Scientific Research, the Netherlands)

Project management at a research organisation

Luísa Sal (University of Aveiro, Portugal)

Strengthening the research management and administration skills in widening institutions - the case of the University of Aveiro

15th March

Auditorium Renato Araújo – Central and Rectorate Building

8:00 – 9:00	**Registration**

Community Building

Chairs: Ana Soares (University of Aveiro, Portugal)

09:30 - 11:00	**Olya Vvendenskaya** (Dragonfly Mental Health**)** Community building workshop for scientists
11:00 - 11:30	**Coffee Break**

Science Innovation

Chairs: Helena Vieira (University of Aveiro, Portugal)

11:30 - 13:00	**Rui Quinta** (With Company, Portugal) Designing future-proof innovations
13:00 - 14:30	**Lunch Break**
14:30 - 16:00	**Rui Quinta** (With Company, Portugal) Principles in practice: innovate through empathy, collaboration, and experimentation
16:00 - 16:30	**Closing Remarks** **João Borges** (University of Aveiro, Portugal)

INVITED SPEAKERS

SHORT BIOS | ABSTRACTS

LIST OF PRESENTATIONS

Career Routes

E.W. “Bert” Meijer

Eidhoven University of
Tecnhology
The Netherlands

✉ E.W.Meijer@tue.nl

E.W. “Bert” Meijer is Distinguished University Professor in the Molecular Sciences, Professor of Organic Chemistry at the Eindhoven University of Technology. After receiving his PhD degree at the University of Groningen with Hans Wynberg, he worked for 10 years in industry (Philips and DSM). In 1991 he was appointed in Eindhoven, while in the meantime he has part-time positions in Nijmegen, MPI-Mainz, Santa Barbara, CA and Sydney. Bert Meijer is a member of many editorial advisory boards, including Advanced Materials and is associate editor of the Journal of the American Chemical Society. Bert Meijer has received several awards, including the Spinoza Award (2001), the ACS Award for Polymer Chemistry (2006), the AkzoNobel Science Award (2010), Cope Scholar Award of the ACS (2012), the Prelog Medal (2014), the Nagoya Gold Medal (2017), the Chirality Medal (2018) and the Van ‘t Hoff and Staudinger Medal (2022). In 2020 he is knighted by the king to be Commander in the Order of the Netherlands Lion. He is an honorable member of several academies and societies, including the US National Academy of Sciences and Royal Netherlands Academy of Science, where he is appointed to Academy Professor in 2014.

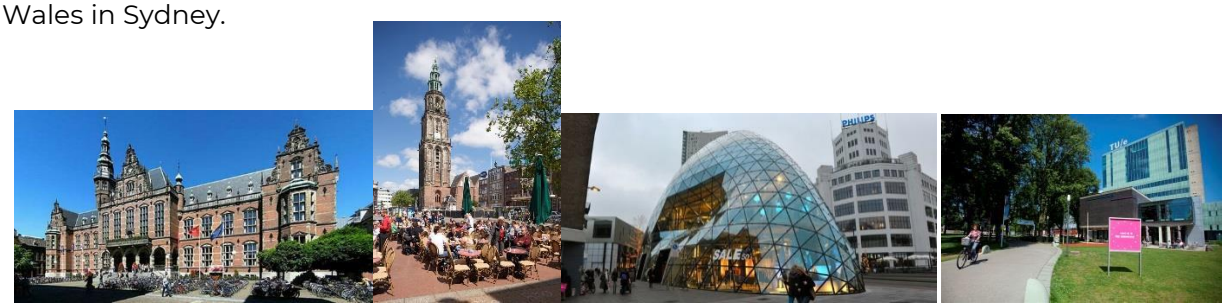
ABSTRACT

A personal journey through my chiral world

Eidhoven University of Tecnhology

I was born in the city of Groningen in 1955 and moved even more North in 1961 to Delfzijl – a small seaport town, where I followed by elementary school. After attending secondary school in Appingedam – a 5-kilometer bike route from Delfzijl - where I graduated in 1972, I started studying chemistry at the University of Groningen and become fascinated by molecules due to my encounter with Professor Hans Wynberg. As a result I continued my education in Organic Chemistry in Groningen. I obtained my master's degree in 1978 and subsequently earned my PhD degree under supervision of Professor Hans Wynberg in 1982. I graduated with his thesis on 'Chemiluminescence in action: syntheses, properties, and applications of 1,2-dioxetanes'. Next to molecules, I was fully taken by everything that is chiral and stereochemistry is my favorite part of chemistry.

Due to the oil crisis, the number of jobs were very limited and the growth of universities was stopped and I was very lucky to get an offer of the Philips Research Laboratories in Eindhoven as a research scientist in Molecular Materials. In 1989 I moved to DSM Research in Geleen to become head of the department for New Materials. In 1991, I was offered a full professorship of Organic Chemistry at the department for Chemistry & Chemical Engineering of Eindhoven University of Technology (TU/e) and in 1999 at the department for Biomedical Engineering at the same university. Since 2004, I became a distinguished university professor of Molecular Sciences at TU/e and initiated the Institute for Complex Molecular Systems in 2008. Next to Eindhoven, I have connections with the Radboud University in Nijmegen, University of California Santa Barbara, Max Planck Institute for Polymer Research in Mainz and the University of new South Wales in Sydney.



In the lecture, I will share my thoughts and continuous doubts on what to decide in my career, but I will also show which people have been essential in my career and life and how they influenced the choices made, while some of the important turns in my life where totally incidental. However, above all I have the privileged to be surrounded by great mentors, friends and family.

Béatrice Adelizzi

DNA Script
France

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Beatrice received her PhD in 2019 from Eindhoven University of Technology (NL) with a thesis on supramolecular materials for optoelectronic applications under the supervision of E.W. (Bert) Meijer. During her studies, she had the occasion to participate to multiple international collaborations (Weizmann Institute, Nagoya University, University of Manchester) which resulted in 10 peer-reviewed publications including 1 Nature and 5 JACS. Beatrice then join the group of Ludovic Julien at École Normale Supérieure (FR) as postdoctoral fellow after winning the Dutch NWO grant Rubicon and the European MSCA individual fellowship for her studies on photoswitchable non-covalent proteins for photoacoustic imaging.
In 2021, Beatrice joined the advanced research group of DNA Script as surface chemist. Since June 2022, she leads the inkjet synthesis team focused on inkjet enzymatic DNA synthesis, inks formulations, and surface chemistry of 2D solid supports.

ABSTRACT

The exercise of steering your career

DNA Script, Le Kremlin Bicêtre, France

After few years in the Italian national team of synchronized swimming, I took my first choice of moving into science. That choice resulted in a series of consecutive crossroads and choices that had defined my career as multidisciplinary scientist ever since. We will discuss about the exercise of constantly steering your career, the process I use for selecting my career path, and the difficulties encountered. I will share my experience transitioning from an academic career to a career in industry, the skills necessary for succeeding and what I learned, and still want to learn, once I joined the startup environment.

Helena Vieira

University of Aveiro

Portugal

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Helena Vieira is Coordinator Researcher and ERA CHAIR Holder in Environmental Economics and Natural Resources Management at University of Aveiro, Portugal.
Responsible for launching and coordinating a new team at CESAM R&D unit, joining natural and socio-economics sciences to develop sustainable solutions. Also Chair of the Scientific Committee of Circular BioBased Europe (CBE-JU), an EU based public private partnership to promote bioeconomy and circularity models and a Board Member of EU Mission Restore our Oceans and Waters. Previously acted as Director General of Maritime Policy under the Minister of the Sea, XXII Government of Portugal. PhD in Biomedicine from Imperial College of London, and Executive Post-graduated from Harvard Business School, speaks 5 languages and loves to dive in the ocean.

ABSTRACT

Widening in Horizon Europe: empowering people and institutions

Fundação para a Ciência e a Tecnologia, I. P., Portugal

Widening Participation and Strengthening the ERA (WIDERA) encourages leadership and the fulfilment of the collective and individual R&I potential through mentoring, networking, communication, and partnering activities [1]. It assumes the role of pre-portal to successful applications in other highly competitive EU funding schemes (e.g., European Research Council or Marie Skłodowska-Curie Actions), but it also contributes to the internationalization process of the scientific communities, at all stages of their careers. In a more ambitious and strategic dimension, the Widening part of the WIDERA programme represents a steppingstone towards systemic transformations of the national R&I ecosystems, institutional reforms, and a mechanism to strengthen (or to build new) collaborations between the academic and non-academic sectors. In this talk, it will be discussed the advantages of participating in networking and capacity building activities, and how the Widening programme may be the right answer to institutional growth or to career development.

References:

[1] Widening Participation and Strengthening the ERA (WP2023-2024): https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2023-2024/wp-11-widening-participation-and-strengthening-the-european-research-area_horizon-2023-2024_en.pdf

Scientific Publishing & Ethics

Sébastien Lecommandoux

University of Bordeaux

France

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Sébastien Lecommandoux received his Ph.D. (1996) in Physical Chemistry from the University of Bordeaux, France. After a postdoctoral experience at the University of Illinois (UIUC, USA) in the group of Prof. Samuel I. Stupp, he started his academic career at the Laboratoire de Chimie des Polymères Organiques as Associate Professor in 1998 and was promoted to Full Professor at Bordeaux INP in 2005. He is currently Director of the Laboratoire de Chimie des Polymères Organiques (LCPO-CNRS) and is leading the group “Polymers Self-Assembly and Life Sciences”. His research interests include the design of bio-inspired polymers for biomaterials design and pharmaceutical development, especially based on polypeptide, proteins and polysaccharide-based block copolymers self-assembly, the design of polymersomes for drug delivery and theranostics, as well as biomimetic approaches toward the design of synthetic viruses and artificial cells. He published over 220 publications in international journal, 6 book chapters and 12 patents (2 being licensed), with over 17000 citations (h-factor 66, Google Scholar). He is also co-director of the joint laboratory LCPO-L'OREAL. Sébastien Lecommandoux is recipient of the CNRS bronze medal (2004), Institut Universitaire de France Junior Chair (IUF 2007), Fellow of the Royal Society of Chemistry RSC (2017), Seqens Award of the French Academy of Science (2019), Member of the Academia Europaea (2020), and XingDa Lectureship Award from Peking University (2021). He has been Editor-in-Chief of Biomacromolecules (ACS) since 2020 after serving as Associate Editor since 2013. He is also in the Editorial Advisory Board of several international journals, including Bioconjugate Chemistry (ACS), Polymer Chemistry (RSC) and Biomaterials Science (RSC).

E.W. “Bert” Meijer

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E.W. “Bert” Meijer is Distinguished University Professor in the Molecular Sciences, Professor of Organic Chemistry at the Eindhoven University of Technology. After receiving his PhD degree at the University of Groningen with Hans Wynberg, he worked for 10 years in industry (Philips and DSM). In 1991 he was appointed in Eindhoven, while in the meantime he has part-time positions in Nijmegen, MPI-Mainz, Santa Barbara, CA and Sydney. Bert Meijer is a member of many editorial advisory boards, including Advanced Materials and is associate editor of the Journal of the American Chemical Society. Bert Meijer has received several awards, including the Spinoza Award (2001), the ACS Award for Polymer Chemistry (2006), the AkzoNobel Science Award (2010), Cope Scholar Award of the ACS (2012), the Prelog Medal (2014), the Nagoya Gold Medal (2017), the Chirality Medal (2018) and the Van ‘t Hoff and Staudinger Medal (2022). In 2020 he is knighted by the king to be Commander in the Order of the Netherlands Lion. He is an honorable member of several academies and societies, including the US National Academy of Sciences and Royal Netherlands Academy of Science, where he is appointed to Academy Professor in 2014.

ABSTRACT

Publishing your science in scientific journals: JACS and Biomacromolecules as examples

Sébastien Lecommandoux[1] and E.W. "Bert" Meijer[2]

1 Laboratoire de Chimie des Polymères Organiques (LCPO), University of Bordeaux, France

2 Institute for Complex Molecular Systems, Eindhoven University of Technology, Eindhoven, the Netherlands

It is April 1879 when a group of 35 chemists of the American Chemical Society in New York City decided to start publishing their novel chemistry in a new journal. It is called the Journal of the American Chemical Society (JACS)and since then it is the flagship journal of the ACS. According to Charles F. Chandler, one of the co-founders, the new society would "prove a powerful and healthy stimulus to original research ..., would awaken and develop much talent now wasting in isolation ..., [bring] members of the association into closer union, and ensure a better appreciation of our science and its students on the part of the general public."

Since that original time, ACS Publications, a nonprofit society publisher, supports the global chemistry community through 90+ journals known for rigorous peer review and high editorial standards.

The Editor-in-Chief of JACS, Professor Erick Carreira, together with the Board of Editors and the Editorial Advisory Board, whose members are leading academic and industrial chemists representing all the chemical disciplines, are ultimately responsible for the excellence of the Journal. The Editors are aided in their task by an able, dedicated staff. JACS publishes roughly 2,500 articles each year, across all areas of chemistry. This includes 1,700 full articles, 700 Communications, and a small number of Perspectives — key insights from top researchers into where their field is headed.

Biomacromolecules is one of the "more specialized" journals from ACS Publications portfolio that is the leading forum for the dissemination of cutting-edge research at the interface of polymer science and biology. As we commemorate the 25th anniversary of Biomacromolecules this year, it is timely to recognize that our journal has provided a platform for researchers to share their innovations and shape the trajectory of the field at the broad interface between polymer science and biology. Biomacromolecules publishes about 500 articles each year, mostly as full articles with a small number of Reviews and Perspectives usually on invitation and from top researchers in the field.

Mental Health Basics and Imposter Phenomenon in Academia

Olya Vvendenskaya

Dragonfly Mental Health

✉ olya@dragonflymentalhealth.org

Olya was born in Moscow, Russia. She studied medicine specializing in medical biophysics in Moscow and worked on her MD thesis devoted to traumatic brain injury and mass spectrometry at the University of Pittsburgh, USA. She further did her PhD in Berlin, Germany working on a multi-omics approach to research of liver cancer and pre-cancerous conditions. She continued her work in translational medicine and mass spectrometry in Dresden, working as a postdoc in MPI-CBG. Currently, she works as a Scientific communications officer in a German biotech company. Additionally, to her main job, Olga devotes her to academic mental health advocacy and scientific community building. She is a co-founder of Dragonfly Mental Health and Sci.STEPS mentoring program.

ABSTRACT

Mental health basics and imposter phenomenon in academia

Dragonfly Mental Health

There are many misconceptions about psychiatric disease, what causes it, who is at risk, and how it manifests. Increasingly we are understanding how immense a problem this is within academia. During this talk, we will cover the information about the prevalence of mental health illness in general and academic populations, an overview of signs and symptoms highlighting those seen in academic settings, and the science underlying the causes and treatments of mental illnesses. We will also discuss the imposter phenomenon, or the feeling that you don't truly belong, that is very common among academics. The presence of the imposter phenomenon is not at all linked to one's academic achievement record or the amount of effort put into science. A positive assessment of one's achievements is only a temporary fix to relieve the anxiety imposter phenomenon can cause. Imposter phenomenon robs us of the joys life has to offer, in both everyday life and in the pursuit of knowledge. We will cover the definition of impostor phenomenon and its prevalence in the academic population. We provide an overview of symptoms highlighting those seen in academic settings, and we facilitate community discussion on how to overcome impostor phenomenon in our individual lives.

CV Writing for Academia vs. Industry

Paula Perez

Institute of Research and
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Paula López Pérez has an original background in Chemistry from University of Santiago de Compostela (Spain); a PhD in Biomedical Engineering from the University of Minho (Portugal) and 7 years of postdoctoral experience with her core fields of research spanning from biomaterials development and tissue engineering to fundamental molecular biology and anti-microbial peptides. Since she started the PhD, she worked in five academic labs and one company across five different countries, experiencing very different working practices and mingled with people of extremely diverse cultural, ethnic and religious backgrounds.

This experience together with her natural drive of building and nurturing human relationships at the workplace and beyond woke up her interest in professional development and now she acts as Career Development Unit Coordinator at Instituto de Investigação e Inovação em Saúde – i3S (Universidade do Porto).

ABSTRACT

Navigating Career Development: Crafting Your Path in Academia and Industry

i3S - Instituto de Investigação e Inovação em Saúde da Universidade do Porto

The individual career journey is a dynamic process marked by choices, opportunities, and challenges. From the earliest stages of research to master's, PhDs, and postdocs, understanding the essence of career development is noteworthy. In this session, we will delve into the intricate interplay between individual aspirations, contextual factors, and broader trends, fostering a deeper understanding of the complexities inherent in career decision-making and progression.

Our exploration will extend to the distinctive landscapes of academia and industry, spotlighting the divergent pathways and essential competencies for each domain. We will discuss practical strategies for career exploration and planning, including crafting CVs and cover letters tailored to specific professional contexts. Ultimately, this session serves as an encouragement of guidance, offering some theoretical frameworks and practical tools to navigate the complexities of career development with some more confidence and clarity.

Diversity, Equity and Inclusion in Science

Alejandra Palermo

The Royal Society of Chemistry
United Kingdom

✉ PalermoA@rsc.org

Alejandra Palermo (Head of Global Inclusion Royal Society of Chemistry) is a chemical engineer with a PhD in materials science and a former researcher and academic.

She is currently responsible for global inclusion at the RSC leading a team working in leading, developing and implementing our overall strategy for inclusion and diversity in the chemical sciences. She also leads international priority areas that include large international programmes in Africa and the Commonwealth and their international engagement with key organisations and chemical societies and federations across the world. The common objective is to drive change towards an inclusive global chemistry culture.

She is an FRSC, a life fellow of the Chemical Research Society of India, and an honorary Fellow of the Chemical Society of Ethiopia. Since 2023, she is a member of the Executive Board of Commonwealth Chemistry and more recently, she has been elected member of the Science Board of the International Union of Pure and Applied Chemistry within the recently established IUPAC governance structure. She is also a member of the EuChemS task group on I&D since 2022.

During the talk, as a case study, it will be presented data and evidence behind the inequalities observed in chemistry and it will be shared some of the interventions initiated by the Royal Society of Chemistry, that can make the chemical sciences fairer and more inclusive for everyone. Hoping to stimulate discussion between everyone on a broad range of topics including creating an inclusive research culture and challenging the traditional measures of success.

ABSTRACT

Diversity, Equity and Inclusion in Science

Royal Society of Chemistry, Burlington House, Piccadilly, London W1J 0BA, United Kingdom

It is generally recognised that to get the very best scientific outputs we need a diversity of inputs and talents [1,6]. However, progress is still slow and yet not well understood or actioned on how to truly achieve diversity and how to ensure that those diverse inputs and talents are included, accepted, valued and empowered.

Current evidence shows that there is a continuous struggle for equality in science, particularly in attracting, retaining and developing talented people from underrepresented groups into positions of leadership.

Given the global nature of science and the scale of the issues identified, there is no doubt that it is imperative to work collaboratively across the scientific community.

During my talk, as a case study, I will present data and evidence behind the inequalities observed in chemistry and share some of the interventions initiated by the Royal Society of Chemistry, that can make the chemical sciences fairer and more inclusive for everyone. I hope to stimulate discussion between ourselves on a broad range of topics including creating an inclusive research culture and challenging the traditional measures of success.

References

[1] Diversity landscape of the chemical sciences

[2] Breaking the barriers: Women's retention and progression in the chemical sciences

[3] Exploring the workplace for LGBT+ physical scientists

[4] A sense of belonging in the chemical sciences

[5] Missing elements: Racial and ethnic inequalities in the chemical sciences

[6] Is publishing in the chemical sciences gender biased?

Open Science

Antónia Correia

University of Minho
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Antónia Correia (Scientific Information Management, Repositories and Open Science Office at the University of Minho, Portugal) is an information specialist for European projects such as PATHOS, PATTERN, EOSC-Future, On-MERRIT, FIT4RRI, and FOSTERPlus at the Scientific Information Management, Repositories and Open Science Office at the University of Minho. Working for the FOSTER Plus project, she coordinated the Portuguese translation of the Open Science Training Handbook and collaborated in the Open Science Training Toolkit . She has extensive experience working in academic libraries and supporting researchers in scientific publishing, visibility and evaluation. Currently a PhD candidate in Education, she integrates the OpenAIRE and Portuguese Communities of Practice for training coordinators and participates as a trainer in the OpenAIRE Open Science Train the Trainer Bootcamps.

ABSTRACT

Open Science as a pillar of Responsible Research

University of Minho

Over the last years, Open Science, the movement to make scientific research more transparent, collaborative and accessible to society, and Responsible Research and Innovation - RRI, which alongside Open Science incorporates concepts such as Governance, Science Education, Public Engagement, Gender, and Ethics – have been gaining importance in the European Commission's research agenda. Following an initial Open Access (OA) pilot in FP7, mandates for OA to publications and data were applied in all thematic areas of Horizon 2020, and reinforced in Horizon Europe.

This session will highlight the key concepts and benefits of Open Science, the pillars and dimensions of RRI, as well as the main the policies and requirements of Horizon 2020 and Horizon Europe regarding open access to publications and how to apply them in the context of funded projects.

References:

Annotated Grant Agreement (AGA) https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/common/guidance/aga_en.pdf .

Burgelman, Jean-Claude, and Corina Pascu. 2019. "Open Science, Open Data, and Open Scholarship: European Policies to Make Science Fit for the Twenty-First Century" 2: 6.

European Commission, Directorate-General for Research and Innovation, Horizon Europe, open science – Early knowledge and data sharing, and open collaboration, Publications Office of the European Union, 2021, https://data.europa.eu/doi/10.2777/18252 .

HE Programme Guide https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/programme-guide_horizon_v3.0_en.pdf .

Diana Silva

University of Aveiro

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Diana Silva (Library, Information and Museology Services of the University of Aveiro, Portugal) is an academic librarian with extensive experience for about 22 years working with scientific information and repositories, promoting information and digital literacy skills and supporting research community in scientific publishing and Open Science. Works as a trainer in higher education institutions on ethical use of scientific information, scientific publishing and Open Science practices. Member of the Higher Education Libraries Working Group of the Portuguese Association of Librarians, Archivists and Documentalists, and is co-author of the Recommendations for Higher Education Libraries in Portugal 2020-2022.

ABSTRACT

UA Open Science tools & services: FCT transformative agreements, Institutional Repository & Data Repository

Library, Document Management and Museology Services - University of Aveiro

Open Science is an approach to the scientific process that focuses on spreading scientific knowledge as soon as it is available using digital and collaborative technology and a set of practices in which the process, content, and outcomes of research are openly accessible by default. When scientific and technological activities are funded by public resources, the adoption of Open Science practices becomes even more crucial. Open Access (OA) and Research Data Management are some of the mandatory practices of funders, as European Commission and FCT, that have been reinforced by the Plan S. In this session we will briefly present the University of Aveiro (UA) platforms and services that enable and facilitate researchers to apply Open Science practices: OA institutional repository RIA, trusted and interoperable, DUnAs, the institutional research data repository and the related research support services, provided by UA Library Services. The FCT/B-on transformative agreements for OA publishing also will be presented, focusing on the conditions for UA authors to publish articles.

Data Management

Julian Dederke

ETH Zürich
Switzerland
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Dr. Julian Dederke works as a consultant for Research Data Management and Knowledge Management at the library of ETH Zurich, the largest technical university in Switzerland. He offers trainings and consulting on aspects of research data management and currently leads a project on implementing data stewardship at ETH Zurich. Julian Dederke has a background in Social Sciences and EU law and has worked in research, teaching and consulting in Germany, Sweden and Switzerland.

ABSTRACT

Data Management – An Introduction to Good Practice in Handling your Research Data

ETH Library, ETH Zurich, CH-8092 Zurich, Switzerland

In today's research landscape, the volume and complexity of data generated across diverse disciplines continue to surge, underscoring the critical importance of robust data management practices. This lecture provides a comprehensive overview of strategies and best practice principles for handling research data.

Participants will learn about key aspects of the different stages of the data lifecycle, from data management planning and organisation to data preservation and sharing.

Attendees will gain an understanding of the following core topics:

- Best practices for data management according to the FAIR data principles
- Strategies for data documentation and metadata creation
- Open Science aspects of data handling and principles of data publishing
- Advise on identifying suitable data repositories for publishing research data
- Importance of data preservation for ensuring the longevity and accessibility of research outputs
- Compliance with institutional and funder requirements for data archiving
- Adoption of standards for long-term data preservation.
- Ethical and legal boundary conditions of research data handling and sharing

The lecture equips students and researchers with the knowledge necessary to navigate the terrain of research data management. Embracing effective data management practices supports participants to enhance the quality and impact of their research and equips them with valuable knowledge to contribute to the advancement of Open Science and scholarly collaboration.

Acknowledgments: This abstract was partly inspired by ChatGPT 3.5, version 21 February 2024 (OpenAI 2021).

References:

OpenAI. (2021). GPT-3.5 (ChatGPT) [Computer software]. Retrieved from https://openai.com, accessed 21.02.2024.

Community building workshop for scientists

Olya Vvendenskaya

Dragonfly Mental Health

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Olya was born in Moscow, Russia. She studied medicine specializing in medical biophysics in Moscow and worked on her MD thesis devoted to traumatic brain injury and mass spectrometry at the University of Pittsburgh, USA. She further did her PhD in Berlin, Germany working on a multi-omics approach to research of liver cancer and pre-cancerous conditions. She continued her work in translational medicine and mass spectrometry in Dresden, working as a postdoc in MPI-CBG. Currently, she works as a Scientific communications officer in a German biotech company. Additionally, to her main job, Olga devotes her to academic mental health advocacy and scientific community building. She is a co-founder of Dragonfly Mental Health and Sci.STEPS mentoring program.

ABSTRACT

Community building workshop for scientists

Dragonfly Mental Health

Sufficient and thriving communities encourage and facilitate for the participants to engage, collaborate, network, share information about funding and resources. Peer support and mentoring, community support, outreach, communication and response to external calls or hardships are additional potential benefits of the strong community. This workshop aims to provide the tools for science-oriented communities, and for the communities that would improve the well-being of researchers, such as mental health peer networks or wellbeing committees. Target audience of the workshop includes scientists, community, consortium project and grant managers, and support staff members. As a result of this workshop the participants will have a detailed overview of the community they would like to build and next steps to take. While the overview is not intended to be a full step-by-step guide, it will help the participants to define the main goals, targeted groups, and the actions they may need to take in order to create a scientific community.

Project Management

Bart Jansen

Netherlands Organisation for Applied Scientific
Research
The Netherlands

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Bart Jansen Studied Chemical Engineering in Utrecht and he is working at TNO for about 15 years. Started as researcher on emission estimates and inventories. Later been working on sustainability assessments (life cycle assessments). Since almost 5 years doing increasingly more and more project management. Since the end of 2021 full time project manager. At the moment a project portfolio of about 10 projects. Some examples are the (internal) PM for EU project with about 1.2 M€ turn-over in 4 years and an internal project of about 1M€ for 1 year. Also the TNO project manager for the FONDA project (FONDA (ua.pt)), in which also assisting the consortium lead is expected.

ABSTRACT

Project management at a research organisation

TNO the Netherlands Organization for Applied Scientific Research

Within this presentation the following topics will be discussed;

What is project management in general?

Let's talk about the project triangle, planning, creating a team, managing stakeholders and risks.

What makes magaging a research project different?

Outcome of research is not certain, while the project outcome is determined. How does this influence the work of a project manager?

How do you manage the content if the content is complexer than your own knowledge?

Figure 1. Teamwork and the project

References:
Book; John Hermarij, Better practices of project management (based on IPMA competences), Van Haren Publicing, 4th revised edition.

Luísa Sal

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Luísa Sal (Research support office (GAI)) holds a Master's degree in Economics and a postgraduate degree in Human Resources Management. Between 2002 and 2010, she was part of the Project Support Office Team at the Financial Services of the Universidade de Aveiro. In 2010, she was appointed as advisor of the Vice-Rector for Research, and, in 2011, she joined the new Research Support Office, of which she is the current Coordinator. She has extensive experience in the management of national and European-funded research projects, and in supporting the preparation and submission of applications within the scope of the different funding programs. She represents the Universidade de Aveiro at the ECIU R&I Group, as part of its participation in the European Consortium of Innovative Universities, she is/was a team member of several projects, such as EPIVIRAL (TWINNING-H2020), SUPRALIFE and ENGINEER (TWINNING - HE), SMART- ER (SWAFS-H2020), ECIU University (ERASMUS+), among others.

ABSTRACT

Strengthening research management and administration skills in widening institutions - the case of Universiade de Aveiro

Gabinete de Apoio à Investigação (GAI), Universidade de Aveiro

Twinning actions intend to help raise the research profile of the institutions from the Widening countries, as well as the research profile of its staff, devoting especial attention to the research management and administrative skills of the coordinator institutions from these countries. As highlighted by ERA Action 17 in the scope of the European Research Area Policy Agenda, research performing entities, local ecosystems and regions who

are proven strong and excellent hubs in knowledge creation and innovation usually rely on a strong community of R&I managers. Laggard countries regions often lack such communities, or communities are less developed. Training highly skilled professionals is, therefore, of upmost importance to boost excellence. In this talk we will demonstrate how the involvement of the Research Support Office (GAI) and other support services of UAveiro in different Twinning projects have been contributing to achieve this goal.

Science Innovation

Rui Quinta

With Company

Portugal

✉ rui@with-company.com

Rui Quinta (Managing Partner & Executive Creative Director at With Company Portugal) Co-founded the space experience design studio, Toyno and With Company, a Lisbon based transformative design company, from where he tries to help others better everything.

He’s an invited lecturer of Futures, Strategic Design, Creativity and Innovation at ISEG and also teaches Design Management and Entrepreneurship at the Faculty of Fine Arts in Lisbon. Since 2012, he's been coaching teams on Design Thinking and Innovation with the Hasso Plattner Institute Academy from Berlin and Porto Business School.

With a taste for big audiences he loves to develop content about the things he's most curious, passionate or knowledgeable about. As a result of that, he's been frequently assigned as a speaker.

Some stages where he had the most fun:

- From Branding a startup to a startup ecosystem - BCreative Tracks - Seoul
- Designing the ways out of boredom - StartupGuide - Berlin
- The age of ageing - Bayer/ImpactHub - Lisbon
- Anxiety. Living a Hypertiny life - Creative Mornings - Lisbon
- Cross-Disciplinary innovation - BCreative Representative - Shanghai
- Designing the conditions to design everything - TEDx - Lisbon
- How can we use our past to design a better future - IDW - University of Zaragoza
- One can be diverse - Designing Tomorrow's Organisational Cultures - Lisbon
- Digital participatory design - Ouishare Fest - Paris

ABSTRACT

Designing future-proof innovations

With Company , Portugal

We will explore how to shape a unique company innovation culture through brand, product and service creation.
How being different just for the sake of being different will never be enough in a planet craving for conscious decision-making. We will find that the truth about brands lies beyond the “self” and lives in the relationship with everything around the product of business. We will reflect on how the future is influencing the ways we manifest ourselves through stories.

Workshop: Principles in Practice - Innovate through Empathy, Collaboration, and Experimentation Empathy (beyond human)

Explore the depths of empathy, transcending boundaries to understand the unspoken needs of users, communities, and even ecosystems. Discover how empathy can be a catalyst for groundbreaking innovations that resonate deeply with the world.
Collaboration (with DEI at its core): Delve into the transformative impact of Diversity, Equity, and Inclusion (DEI) in collaborative settings. Witness how diverse perspectives fuel innovation, fostering a culture where every voice contributes to groundbreaking ideas.
Experimentation (like a 5-year-old): Experience the power of hands-on experimentation using LEGO bricks. Dive into a world of playful yet strategic experimentation, where prototyping and iteration pave the way for innovative breakthroughs. This workshop isn't just about theory—it's about engaging in exercises that embody these principles and sharing inspiring real-world examples. Join us to harness the potential of empathy, collaboration, and experimentation, and unlock new dimensions of innovation.

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