TEMES PER A TREBALLS DE FI DE GRAU (TFG)

GRAU EN BIOTECNOLOGIA
Curs 2025-2026

DEPARTAMENT BIOENGINYERIA

1. Progress in the development of an Innovative method for Exosome Isolation in Alzheimer's Disease Research and Diagnosis

Alzheimer's disease (AD) is a neurodegenerative disease and the first cause of human dementia. Unfortunately, the finding of an effective treatment to slow down the cognitive decline in AD patients remains elusive. In the last years, a revolutionary method has emerged that allows to study the alterations occurring in the brain of alive AD patients through a blood sample. This method consists of the isolation and characterization of blood stream isolated small vesicles, named **exosomes**, originated in almost all kind of cells including neurons, and secreted to the circulatory system. Neuronal exosomes are isolated from other exosomes originated in non-neuronal tissues by means of an antibody against the neuron-specific protein **L1CAM**. However, in the last years, it was found that L1CAM is also expressed in non-neural tissues and certain types of cancer, casting doubts on the purity of the exosomes isolated by this method. Thus, it is crucial to find out new exosomal proteins that show a stronger and a more specific neuronal expression, for the isolation and study of neuronal exosomes derived from the blood of AD patients, in order to advance in our understanding of this devastating disorder. Preliminary data from our laboratories suggests that GRIN2A could be a good candidate for the isolation of neuron-specific EVs from plasma.

The present proposal aims to compare the efficiency of three different methods for the isolation of exosomes based on three different antibodies against neuronal proteins: an antibody against L1CAM (standard protocol), an antibody against the neuronal membrane glycoprotein M6alpha (GPM6A) and an antibody against the brain-specific receptor GRIN2A. These three methods will be compared in terms of their capacity to isolate exosomes from the media of a **neuroblastoma cell line expressing a protein related to AD (SH-SY5Y-APP)**. Then exosomes will be analyzed and **characterized by NTA**, by **flow cytometry**, **western blot** and **ELISA**. The presence of proteins related to AD in the isolated exosomes will be assessed.

This proposal belongs to the project PID2022-138334OB-I00 kindly founded by the Ministerio de Ciencia e Innovación (Plan Estatal de Investigación Científica y Innovación)

Direcció: Dr. Martí Lecina Veciana i Dr. Francesc Xavier Guix Ràfols

2. Building an optogenetic gene expression system for applications in synthetic biology and molecular biotechnology

Brief description: Optogenetics is an emerging discipline that uses light to control genetic circuits in living cells, and it is pioneering research in neurobiology and optopharmacology. In contrast to chemical inducers, light provides fast and reversible responses (millisecond scale diffusion rate) with spatial resolution. Light-switchable control of gene expression typically uses two genetically-encoded proteins that are able to sense the light and transduce this signal into target promoters. We are developing novel synthetic photosensors in microalgae to control the production of high-value bioproducts like recombinant therapeutic proteins and vaccines. Recently, our group has developed a modular cloning kit to facilitate construction of complex multigenic vectors (Melero-Cobo et al 2025).

Objective*:* You will contribute to the construction and analysis of a novel light-switchable sensor in microalgae chloroplasts based on blue-light sensing VIVID and red/far-red sensing phytochrome photoreceptors. These photoreceptors are fused to either LexA-based or Opto-T7 RNA Polymerase split transcriptional effectors. Through light-regulated control of VIVID and Phytochrome photodimerization, the split effectors reassemble and are able to bind promoter and activate the expression of reporter gene. This project should contribute to create new synthetic biology tools for the precise control of recombinant gene expression in microalgae chloroplast synthetic chassis.
Methodology: *Optogenetics and photobiology, gene cloning, gene expression (qRT-PCR, western blot, reporters). More information:*

https://planaslab.iqs.edu/research/synthetic-biology-and-molecular-biotechnology-in-green-microalgae/

Direcció: Dr. Pau Leivar Rico i Dra. Elena Monte

3. Chloroplast engineering of green microalgae for the sustainable production of valuable rhamnolipid biosurfactants

Brief description: Rhamnolipids (RLs) are a class of glycolipid that act as biosurfactants, containing rhamnose as a sugar moiety linked to 3-hydroxylated fatty acid chains. RLs has wide applications in several industries including petroleum, food, agriculture, bioremediation and pharma. Microalgae are unicellular photosynthetic organisms that are emerging as important sustainable hosts for industrial biotechnology, as they can use photosynthetic light to efficiently transform CO_2 into high-value bioproducts.
Recently, our group has developed a modular cloning platform to facilitate construction of complex multigenic vectors (Melero-Cobo et al 2025) and a recombinant microalgae strain that produces the lipid moiety (HAA) of RLs (Miró et al 2023). The aim of this study will be the initial molecular and biochemical characterization of new strains expressing RhlA acyltransferase and RhlB rhamnosyltransferase for the production of HAA and mono-RLs.
Objective*:* Molecular and biochemical characterization of HAA (lipid moiety) and mono-RLs producing strains of the green microalgae *Chlamydomonas reinhardtii*.
Methodology: *Gene expression analysis (qRT-PCR, western blot), RLs analysis (GC, HPLC). More information:*

https://planaslab.iqs.edu/research/synthetic-biology-and-molecular-biotechnology-in-green-microalgae/

Direcció: Dr. Marçal Gallemí Rovira i Dr. Pau Leivar Rico

4. Green rhamnolipid production in the microalgae chlamydomonas reinhardtii

Brief description: Rhamnolipids (RLs) are a class of biosurfactants that contain rhamnose as the sugar moiety linked to β-hydroxylated fatty acid chains, with wide application in many industries including petroleum, food, agriculture, bioremediation and pharma. Recently, our group has developed a recombinant microalgae strain for rhamnolipids production, although no culture optimization studies have been tested yet.

The aim of this study is to characterize RL production under different culture conditions such as autotrophy, mixotrophy and heterotrophy and asses potential scale-up strategies.
Objective*:* Optimization of culture conditions for rhamnolipid production in the microalgae *Chlamydomonas reinhardtii*.
Methodology: *Microalgae cultures, Bioreactor utilization, Design of Experience. More information:*

https://planaslab.iqs.edu/research/synthetic-biology-and-molecular-biotechnology-in-green-microalgae/

Direcció: Dr. Pau Leivar Rico i Dr. Marc Carnicer Heras

5. Studying rhamnosyltranferases binding specificity for the sustainable production of valuable rhamnolipid biosurfactants in green microalgae

Brief description: Rhamnolipids (RLs) are a class of glycolipid that act as biosurfactants, containing rhamnose as a sugar moiety linked to 3-hydroxylated fatty acid chains. RLs has wide applications in several industries including petroleum, food, agriculture, bioremediation and pharma. Microalgae are unicellular photosynthetic organisms that are emerging as important sustainable hosts for industrial biotechnology, as they can use photosynthetic light to efficiently transform CO_2 into high-value bioproducts. Recently, our group has developed recombinant microalgae strains transformed with polygenic constructs to produce mono-rhamnolipids (Miró et al 2023).
Objective*:* The aim of this study will be the structure/function characterization of the second step of rhamnolipid production by analyzing rhamnosyltransferases (glycosyltransferases) donor and acceptor specificity to modulate *in vitro* activity.
Methodology: *Gene cloning and expression. Biochemical characterization. Enzyme kinetics.*

Direcció: Dr. Antoni Planas Sauter i Dr. Pau Leivar Rico

6. New-to-nature glycosidases as bio-orthogonal tools in metabolic labelling and enzyme prodrug therapies

Brief description: Non-natural modified sugars (such as 6'-modified glucosides or ring expanded septanosides) have the potential to be transformative glycomimetics with application in chemical biology and medicinal chemistry. Such modified sugars are insensitive to degradation by hydrolytic enzymes. Therefore, engineering the active site of a glycosidase to be active on these non-natural glycosides will generate a bio-orthogonal non-natural sugar/engineered hydrolase pair. Transfected cells expressing the engineered glycosidase will allow the highly selective and time-resolved delivery of molecular cargoes inside cells. We are particularly interested in applying the pairs to "antibody directed enzyme prodrug therapy" (ADEPT) and time-resolved intracellular release of conjugates for metabolic labeling studies. First application will address ADEPT that intentionally adds an enzyme as part of the therapeutic modality to specifically liberate the bioactive compound. Competing background reactions from endogenous enzymes and the immunogenicity of the enzyme being introduced can hamper these efforts. Our contribution is the development of a platform that will deliver a specific biorthogonal glycosylated small molecule – engineered enzyme pair ready for

application to prodrug development efforts. The pair will enable the spatiotemporal targeted activation of anti-cancer drugs to solid tumors with greater selectivity in the cleavage of the prodrug and the ability to better tune properties related to both the enzyme and the substrate followed by conjugation to the carrier antibody.
Objective: In this project, we will contribute to engineer a novel (new-to-nature) glycosyl hydrolase (bioorthogonal glycosidase) that selectively cleaves 6'-modified glycosides or septanosyl glycosides *in vitro* and in cells that recombinantly produce the enzyme. We have recently shown that fluorescent-labelled septanosides are uptaken by cells (Pote et al.2021) enabling *in vivo* selection strategies. You will develop and implement a targeted directed evolution approach by Iterative Saturation Mutagenesis (ISM) combined with fluorescence-assisted cell sorting (FACS) screening of large libraries using the fluorogenic substrates recently synthesized in collaboration with Dr. M. Peczuh (University of Connecticut, USA. The novel bioorthogonal hydrolase will be characterized for the bioorthogonal unmasking of functional probes *in vivo*. You will work in close collaboration with Dr. Karel Hernández, postdoctoral researcher in the group.
Methodology: *molecular biology, gene library preparation, HTS by FACS and robotic platfom, protein expression, enzyme kinetics and characterization.*

Direcció: Dr. Antoni Planas Sauter

7. Peptidoglycan deacetylases as antimicrobial targets

Brief description: The alarming emergence of multi-drug resistant pathogenic bacteria demands novel strategies and new therapeutic targets to combat difficult-to-treat infections. Several microbial pathogens have developed sophisticated strategies to evade or modulate the host response to their advantage. The mammalian immune system uses a range of hydrolytic enzymes to fragment and destroy the bacterial peptidoglycan layer allowing activation of specific immune responses. A number of pathogenic bacteria, including *Streptococcus pneumoniae, Bacillus anthracis, Helicobacter pilori, Clostridium difficile, etc,* protect their peptidoglycan cell wall from the action of the host innate immune system by partial deacetylation of their cell wall peptidoglycan. The Laboratory is studying the structural/functional relationships of this family of enzymes by means of enzyme discovery, protein engineering and X-ray crystallography (Grifoll et al. 2019, Pascual & Planas, 2021, Planas 2022). Understanding the specificity for GlcNAc or MurNAc deacetylation is central to develop strategies to block the function of peptidoglycan deacetylases and validate the enzymes as pharmacological targets. Recently we have performed a bioinformatics search of putative novel enzymes and selected a number of candidates to evaluate their function and specificity.
Objective: The objective of the project is to identify novel PGN deacetylases from pathogens and evaluate the effect of active site mutations on enzyme selectivity addressed to delineate the structural determinants in this family of enzymes for the design of inhibitors as potential drugs against bacterial infections. You will express selected deacetylases and prepare a library of active site mutants to identify key residues involved in binding and specificity.
More information: link

Methodology: *molecular biology, mutagenesis, protein engineering, protein expression and purification, activity assays (HPLC-MS, spectrophotometry).*

Direcció: Dr. Antoni Planas Sauter

8. Engineering a secretory pathway for the producion of a recombinant deacetylase enzyme in e. coli at pilot plant scale

Brief description: In the framework of the European project CROPSAFE (Crop Protection Strategies for the Transition to Environmentally-Friendly Agriculture), we are interested in the production of modified chitosans with non-random deacetylation pattern by specific and targeted deacetylation of novel chitosans from fungal origin to be tested as plant protectants with antifungal and disease resistance bioactivities for applications in agriculture. Target cultivars for field trials in the CROSAFE project are tomatoes (to combat *Potato Cyst Nematode (PCN))*, potatoes (to combat *Root Knot Nematode (RKN)*) and bananas (to combat *Banana Weevil (BW) and Fusarum fungus).* Fungal chitosans will be treated with our developed deacetylase *Bs*PdaC (Grifoll et al. 2019) for which we have to scale up the enzyme production in bioreactor at pilot plant. Currently the enzyme is expressed intracellularly in *E.coli*. To simplify the downstream processing (DSP) at large scale, we are attempting the construction of a secretory system in *E. coli* to produce the enzyme extracellularly.
Objective: The objective of the project is to construct enzyme variants for secretion to the extracellular medium to facilitate DSP using two strategies: (i) periplasmic expression via fusion to a signal peptide, and (ii) extracellular expression via the Type I secretion system (T1SS) through C-terminal fusion to the HlyA secretion signal. Current designs will be improved for efficient expression. Efficient strains will be transferred to our Bioprocess Pilot Plant for scale up production.
Methodology: *Molecular biology, protein expression, production in bioreactor, DSP*

Direcció: Dr. Antoni Planas Sauter i Dr. Marc Carnicer Heras

9. *Discovering enzymes and lectins that target human glycans for therapeutic applications*

Brief description: Glycans, the complex sugars decorating the surface of cells, play key roles in biological recognition, immune defense, and infection. Aberrant glycan formation is a hallmark of many cancers, where it influences tumor progression, metastasis, and immune evasion. Similarly, some pathogens, such as *Pseudomonas aeruginosa*, exploit specific human glycans to adhere to host cells and avoid immune detection. The proteins involved in these processes include not only enzymes that build or degrade glycans (*Carbohydrate-Active enZYmes*, or CAZymes), but also *lectins*, which recognize and bind them.
In this project, you will explore both enzyme and lectin families to discover new proteins with biomedical potential. Using artificial intelligence and molecular modeling, you will predict how these proteins interact with human glycans and identify those that could be targeted to prevent infection or modulate immune responses.
Objective: To identify and characterize new CAZymes and lectins guided by their recognition of human glycan structures relevant to infection and immunity.
Methodology: Protein structure prediction (AlphaFold, Boltz-2); molecular docking (AutoDock); programming and data analysis (Python, Bash).

Expected learning outcomes: You will gain experience in AI-assisted discovery of biomolecular interactions, molecular modeling, and bioinformatics. You will learn how protein–glycan recognition shapes infection and immunity, and how computational tools can guide therapeutic discovery. Full-time dedicated.

Direcció: Dr. Xavier Biarnés Fontal

10. in-silico protein engineering of a carbohydrate active enzyme as biocatalyst to produce added-value oligosaccharides.

Brief description: Protein engineering can be guided by computer-assisted calculations. In our group we have developed the BindScan algorithm which allows identifying positions along the protein sequence of an enzyme that are expected to improve enzymatic activity towards a desired substrate. Carbohydrate active enzymes can be engineered to achieve new biocatalysts that make possible the efficient synthesis of added-value oligosaccharides. In the framework of a National Research Grant, we are interested in re-designing bacterial and fungal carbohydrate enzymes (glycoside hydrolase and carbohydrate esterases). Preliminary results suggest that these enzymes can potentially be used as efficient biocatalysts to produce added value oligosaccharides.
Objective: In this project you will apply the BindScan algorithm on the structure of a bacterial enzyme in complex with substrates. You will implement novel features to the algorithm. The main scope is to identify hot-spots that potentially control the desired activity of the enzyme. These hot-spots will later be tested experimentally in the laboratory.
Methodology: *Molecular Modelling. Docking. More information:* link
Expected learning outcomes: You will develop a solid understanding of computational protein engineering and gain practical skills in molecular modelling, programming, and data analysis. These competencies will prepare you for careers in biotechnology, bioinformatics, and pharmaceutical research, where enzyme design and computational methods are increasingly in demand. Full-time dedicated.

Direcció: Dr. Xavier Biarnés Fontal i Dr. Antoni Planas Sauter

11. Exploring the functional role of lea proteins in response to drought stress.

Brief description: Climate change is one of the most urgent global challenges leading to more intense droughts and high salinity levels in agricultural soils. These environmental stressors are significant threats to ecosystems and are detrimental for agricultural productivity. Therefore, it is critical to elucidate the mechanisms by which plants respond and adapt to drought and salt stress. Although many genes, proteins and metabolites connected to stress adaptation have been identified, the functional relevance for most of these molecules is poorly understood. A clear example is the case of the late embryogenesis abundant (LEA) proteins, which are known to accumulate in plants in response to drought and salt stress, but most LEA functions *in vivo* are still poorly understood.
In our group, we have previously generated transgenic lines expressing LEA proteins fused to GFP (LEA:GFP), enabling visualization of protein dynamics in living cells. This project aims to analyse the response of selected LEA:GFP transgenic lines under drought conditions through Western botting and confocal microscopy. In parallel, available *lea knock-out* mutant will be analysed under controlled water-deficit stress conditions, using physiological and molecular stress markers to assess stress sensitivity and adaptation .

By integrating molecular, biochemical, and imaging approaches, this study aims to explore the specific roles of LEA proteins in plant tolerance to drought-related stresses—including salinity, osmotic stress, and high temperature—across different tissues and developmental stages.
Objective: To characterize the functional role of specific LEA proteins in response to different water-deficit stress conditions, across different plant tissues and developmental stages.
Methodology: *In vitro* seed germination and plant growth, protein extraction and quantification, western blot analyses; confocal microscopy, image analysis and quantification, basic statistical data analysis

Direcció: Dra. Norma Fàbregas Vallvé

12. Induction, generation and characterization of novel plant cell culture lines to produce bioactive compounds

Brief description: Historically, plants have been used for or a wide range of food, pharmaceutical, and cosmetic applications. Today, plant-derived products remain essential worldwide and are gaining popularity as sustainable alternatives to synthetic compounds. However, traditional methods for obtaining plant extracts often face limitations related to environmental dependency, resource use, and low yield.
Recent advances in biotechnology have enabled the use of plant tissue, callus, and cell suspension cultures as innovative systems for the controlled production of bioactive compounds. These cultures, derived from totipotent plant stem cells obtained through phytohormone-induced dedifferentiation, represent a renewable and scalable source of valuable biomolecules with cosmetic, pharmaceutical, or nutraceutical potential. Previous work in our group has successfully implemented the first plant cell cultures at IQS to produce bioactive compounds in specific plant species.
This project aims to contribute to the development and characterization of new plant cell culture lines capable of producing bioactive compounds. Calli will be induced from different explants, and cell suspension cultures will be established to optimize growth and elicitation conditions to enhance metabolite production at the Erlenmeyer flask scale. The resulting plant cell cultures will be further characterized in subsequent studies through transcriptomic and/or metabolomic analyses.
Objective: To develop and optimize novel plant cell culture lines for the sustainable production of bioactive compounds.
Methodology: Induction of calli from explants (leaves, stems, or flowers); establishment of cell suspensions from generated calli; optimization of elicitation conditions to increase biomolecule production at the Erlenmeyer flask scale; preliminary transcriptomics and/or metabolomics analyses.

Direcció: Dr. Martí Lecina Veciana, Dr. Pau Leivar Rico i Dra. Norma Fàbregas Vallvé

13. Identification of beneficial species in the microbiome of coffee plants from guatemala using nanopore sequencing

Brief description: Coffee is one of the most important agricultural commodities worldwide and a source of income for more than 125 million people. However, coffee producers face increasing challenges due to several fluctuating market prices, labour shortages, plant diseases such as coffee leaf rust, and the effects of climate change. Coffee plantations are particularly susceptible to extreme temperatures, variable precipitation patterns (drought and waterlogging), and elevated CO_2 levels. These conditions directly reduce coffee productivity and quality, while also increasing disease incidence. Climate change has been estimated to account for up to 70% of yield reduction in coffee production.

Endophytes—microorganisms that live within plant tissues—form part of the plant microbiome and often provide significant benefits to plant growth, stress tolerance, and defence. These beneficial effects include the synthesis of growth-promoting compounds, antimicrobials against pathogens, and metabolites that improve resilience under adverse environmental conditions.
Genomic sequencing is a powerful technology to identify microbial species within microbiome communities and to analyse their potential functions by analysing their annotated genomes. IQS has recently acquired a MinION sequencing device from Oxford Nanopore Technologies (ONT) to support the implementation of this third-generation sequencing technology in our new emerging research group at the Bioengineering department. Previously, we implemented ONT sequencing at IQS by performing whole genome sequencing and genome annotation of different *E. coli* strains isolates as a proof of concept.
This project aims to identify beneficial microbial species present in the microbiome of coffee plants from Guatemala using ONT sequencing. The analysis of genomic data will allow the identification of candidate endophytes with potential roles in promoting plant growth, improving stress adaptation, or enhancing coffee fermentation processes.
Objective: The main purpose of this project is to identify potential endophytic microorganisms using third-generation genomic sequencing technologies (ONT).
Methodology: DNA extraction and quantification; genomic library preparation; ONT sequencing using the MinION device; bioinformatic analysis.

Direcció: Dra. Norma Fàbregas Vallvé, Dra. Magda Faijes Simona i Dr. Xevi Biarnés Fontal

14. Targeting aberrant glycans in tumor cells by enzymatic hydrolysis

Brief description: Protein glycosylation is a widespread eukaryotic post-translational modification in extracellular and membrane anchored proteins. Protein glycosylation pathways are frequently altered in cancer cells, resulting in aberrant glycan structures that are well-known tumoral markers. Preventing the formation of such abnormal glycans has been reported to diminish tumor progression. One of such aberrant glycan structures is the formation of highly branched structures. These are the result of enhanced expression of MGAT4 and MGAT5 genes by oncogenic transcription factors. Cells with increased MGAT5 expression show increased frequency of metastasis, whereas cells lacking this gene lose the metastatic phenotype. Therapeutic strategies aimed at preventing the formation of such branched glycans have been attempted and are under current research efforts.
Objective: The objective of this research project is to express and characterize a glycosyl hydrolase that specifically hydrolases branched glycans. You will recombinantly express a selection of enzymes that potentially cleave the glycosidic bonds present in highly branched glycans. Previous bioinformatics analysis of the carbohydrate active enzymes database (CAZY) has identified a list of gene candidates with enzymatic activities close to the desired one. You will clone, express, purify and characterize the enzymatic activities of a short selection of genes from this list. The outcome of your investigations will be the characterization of a lead glycoside hydrolase that potentially targets aberrant glycans in tumor cells. This lead enzyme can further be optimized by protein engineering and/or assessed for functionality in cellular studies.

Methodology: Molecular biology, recombinant protein expression and purification, enzymatic characterization.

Direcció: Dra. Magda Faijes Simona i Dr. Xavier Biarnés Fontal

15. Human milk oligosaccharides (HMO) as functional prebiotics. enzyme engineering by directed evolution for hmos production

Brief description and objectives: Human milk oligosaccharides (HMO) furnish breast-fed infants with a number of health benefits as prebiotics and antimicrobial agents as well as exerting immunomodulation effects. There is a huge interest in the health and food sector to supplement infant formula milk with functional HMOs, requiring biotechnological approaches for their production. Lacto-N-tetraose is one of the main core structures that is further extended and functionalized with fucosyl and/or sialyl units at different positions. Using hydrolases involved in HMO catabolism by Bifidobacteria, we aim at engineering GH20 glycosidases into synthetic enzymes by modulating the transglycosylation to hydrolysis ratio towards efficient biocatalysts. By a structure-guided mutagenesis approach of Lacto-N-biosidase from Bifidobacterium bifidus we have been able to introduce transgycosylation activity for the enzymatic synthesis of the major type 1 HMO, lacto-N-tetraose (LNT) up to a 30% yield (Castejón et al, 2021). A step further is to evolve this mutant to reach high preparative yields. Here you will develop different mutants with different affinities and activities at genetic level and expressed them. Hits will be biochemically characterized and crystallized in collaboration with Dr. Shinya Fushinobu from University of Tokyo (Japan)

Methodology: molecular biology, protein purification, enzyme kinetics, crystallization

Direcció: Dra. Magda Faijes Simona, Dr. Xavier Biarnés Fontal i Dr. Antoni Planas Sauter

16. Synthesis and characterization glyconanoparticles as a new glycovaccines to activate inmune system

Brief description and objectives: Nanomedicine plays a fundamental role in today's medicine. This new approach of medicine is enabling the development of prophylactic and therapeutic treatments. Advances in the field of combating cancer or infectious diseases position nanomedicine as an effective and highly promising response, although it is still under development. Notably, immunotherapy, which leverages the body's immune system to fight diseases, has benefited significantly from nanomedicine. Nanoparticles can be designed to improve the delivery and efficacy of immunotherapeutic agents, enhancing the immune system's ability to target cancer cells more precisely. With the emergence of COVID-19 vaccines, the scientific community has focused on developing vaccines based on genetic material to combat various diseases.
We have recently published the design of glyconanoparticles to specifically activate the inmune system presenting the mRNA as antigen and also the galactose moiety to target the nanoparticles to dendritic cells as a key point in terms of effective immunotherapy (Patent 2024, Gónzalez-Rios et al., 2023). Particularly in this project, we desire to synthesize a library of glycopolymers to assay as glyconanoparticles and in cell cultures at IQS and also in vivo at the group of Salome Pinho, Institute for Research and Innovation in Health, Oporto (Portugal). Different mannosyltransferases will be considered to extend the library of glycopolymers
Methodology: sustainability-green chemistry for carbohydrate synthesis, nanoparticles characterization, uptake in cell cultures.

Direcció: Dra. Magda Faijes Simona i Dra. Cristina Fornaguera Puigvert

17. Design and computationally evaluate fusion protein systems optimized for efficient production in escherichia coli with minimal downstream purification requirements

Description: Downstream processing remains a major limitation in recombinant protein production due to its complexity, cost, and impact on product yield and quality. It involves multiple steps—cell disruption, clarification, purification, and formulation—that must efficiently separate the target protein from contaminants such as host proteins, DNA, and endotoxins. Chromatographic methods, although effective, are expensive, time-consuming, and difficult to scale. Consequently, optimizing and simplifying downstream processing is essential to make recombinant protein production more economical, scalable, and suitable for industrial and therapeutic applications.
Bioinformatics has contributed to improve protein purification and formulation by modelling interactions between target proteins and chromatographic materials or excipients. Predictive models can forecast aggregation, degradation, and post-translational modifications, guiding the selection of purification methods and stabilizing conditions.
Objective: To simplify downstream processing and enhance enzyme stability under process conditions, this project will focus on the *in silico* design of optimized fusion proteins aimed at (i) facilitating downstream processing, (ii) enabling straightforward tracking, and (iii) improving structural stability. Computational tools will be employed to model various fusion architectures and predict mutations that enhance the enzyme's robustness while preserving catalytic activity. Finally, the most promising candidates will be expressed in *Escherichia coli* BL21(DE3) to evaluate their performance.

Methodology: Structural Bioinformatics, molecular biology, recombinant protein expression and purification.

Direcció: Dr. Marc Carnicer Heras, Dr. Xevi Biarnés Fontal i Dr. Antoni Planas Sauter

18. Sustainable glycoglycerolipids production based on acetate utilization

Description: A key challenge in industrial biotechnology, which employs microbial cell factories to produce a wide range of compounds, is developing new sustainable production processes that use non-food feedstocks to avoid competition with food supplies. Recently, our research group has developed several recombinant strains capable of accumulating glycoglycerolipids through an optimized acetate-based expression system. This study will evaluate this novel expression system, focusing not only on its ability to produce glycoglycerolipids from non-food feedstocks but also on its impact on cell growth and fitness.
Objective: Evaluate the glycoglycerolipids production of different recombinant strains using acetate.

Methodology: Design of Experience, Bioreactor, TLC, HPLC

Direcció: Dr. Marc Carnicer Heras

19. Third-generation sequencing using nanopore long-reads to detect antibiotic resistance genes

Brief description: The World Health Organization (WHO) considers antibiotic resistance a major global health threat. Despite efforts to control it, the prevalence of resistant infections are increasing, reducing treatment effectiveness and increasinf illness, death rates and healthcare costs. Genomic

approaches for early detection of resistance genes can help fighting against antibiotic resistance. Nanopore-based Third-Generation Sequencing (TGS) makes it possible to obtain complete bacterial genomes by reading single, unamplified DNA molecules as they pass through protein nanopores.
Oxford Nanopore Technologies (ONT) has developed the MinION, a compact, USB-powered sequencing device capable of generating ultra-long reads (>10 kb) without compromising sequence quality. This technology allows rapid, portable, and high-resolution genomic analyses
At IQS, we have previously implemented ONT sequencing using the MinION platform, performing whole-genome sequencing and genome annotation of different E. coli strains isolates as a proof of concept.
This project aims to sequence the genomes of E. coli strains isolated from a wastewater treatment plant to identify and characterize antibiotic resistance genes using Nanopore sequencing.

Objective:To detect and analyze antibiotic resistance genes in E. coli bacterial isolates from wastewater using Nanopore-based third-generation sequencing.

Methodology: Molecular biology (ADN extraction, library preparation), genomic sequencing and bioinformatic analysis.

Direcció: Dra. Norma Fàbregas Vallvé, Dra. Maria Auset Vallejo i Dr. Xevi Biarnés Fontal

20. Nuevos biocidas naturales para combatir infecciones multirresistentes

Introducción: La resistencia bacteriana a los antibióticos es uno de los mayores desafíos de la medicina moderna. Cada año, miles de infecciones dejan de responder a los tratamientos, poniendo en riesgo la salud global y evidenciando la necesidad urgente de nuevas estrategias antimicrobianas.
En este contexto, los aceites esenciales (AE) de plantas aromáticas surgen como una alternativa natural y de gran potencial. Estas mezclas complejas de compuestos volátiles poseen potentes propiedades antibacterianas, antivirales y antifúngicas y son prometedores aliados frente a infecciones causadas por bacterias multirresistentes.

Objetivos: El TFG busca evaluar el potencial antimicrobiano de aceites esenciales naturales —como los de árbol del té *(Melaleuca alternifolia*), canela (*Cinnamomum zeylanicum*) y lavanda (*Lavandula officinalis*)— frente a bacterias patógenas y cepas resistentes, así como determinar el efecto sinérgico de la combinación de AE y antibióticos y su capacidad para reducir la resistencia bacteriana.
Este TFG ofrece un tema de gran relevancia sanitaria donde evaluar productos naturales con potencial terapéutico como alternativa sostenible a los antibióticos tradicionales.

Direcció: Dra. Maria Auset Vallejo

21. Establishment of a 3D culture system for planarian neoblasts to study stem cell maintenance and differentiation.

Planarian neoblasts are adult pluripotent stem cells responsible for the organism's exceptional regenerative ability. However, despite recent advances in their isolation, establishing long-term *in vitro* cultures that preserve their viability, and pluripotency remains a major challenge. This project aims to develop a new protocol to culture planarian neoblasts in three-dimensional (3D) conditions that better reproduce their native microenvironment. The student will adapt existing dissociation and sorting methods, test different 3D matrices, and optimize culture media composition to support cell

survival and proliferation. Given the novelty of this approach, the project will involve troubleshooting and iterative optimization. The final goal is to establish a reproducible 3D culture system that can serve as a basis for future studies on regeneration, tumorigenesis, and epigenetic regulation in planarian stem cells.

Techniques and methodologies used: Planarian culture; cell dissociation; cell cytometry; 3D cultures; molecular biology techniques; immunostaining, *in situ* hybridization, confocal microscopy.

Direcció: Dra. Loli Molina Jiménez i Dr. Carlos Semino

22. Engineering of synthetic protein receptors for enhanced therapeutic delivery to the brain

Summary: Existing drugs for the treatment of brain diseases such as Alzheimer's or cancer present low therapeutic efficacy. The highly impermeable blood-brain barrier (BBB) prevents most drugs from reaching the brain. Strategies leveraging the receptor-mediated transcytosis (RMT) show promise for a more effective drug delivery to the brain. However, no natural receptor has allowed yet an efficient and selective enough brain transport. Our group is developing novel synthetic receptors that will provide enhanced drug delivery to the brain, potentially improving existing treatments for brain diseases.
Project description: In your TFG, you will characterize the synthetic receptors that we are developing by assessing their cellular trafficking and drug delivery potential using *in vitro* BBB transwell models. Your results will be essential for further developing the capabilities of the synthetic receptor candidates. We invite you to take a look at the Chemical & Synthetic Biology for Biotherapies group website (www.chemsynbio.iqs.edu)!
Techniques: Flow cytometry, immunohistochemistry, cell-based assays, western blot, protein expression.

Direcció: Dr. Benjamí Oller Salvia i Dr. Goren Saenz de Pipaon Echarren

23. Engineering degraders for lysosomal elimination of pathogenic proteins in brain and lung cancers

Summary: Targeted Protein Degradation (TPD) has recently emerged as a promising new therapeutic modality. In particular, the degradation of membrane and extracellular proteins has shown great potential over the past five years, relying on lysosomal targeting receptors (LTRs). Bispecific ligands enable the binding of LTRs to proteins of interest, directing these proteins towards lysosomal degradation. In our group, we are developing novel peptides and antibody fragments capable of degrading proteins implicated in the progression of brain and lung cancers.
Project description: In your TFG, you will focus on the production, conjugation and characterization of lysosomal targeting peptides. Once these degraders are produced, you will assess their ability to degrade pathological proteins in cell-based models. Protein degradation will be quantified using techniques such as western blot and flow cytometry.
We invite you to take a look at the Chemical & Synthetic Biology for Biotherapies group website (www.chemsynbio.iqs.edu)!
Techniques: solid-phase peptide synthesis, protein expression, cell-based assays, flow cytometry and western blot.

Direcció: Dra. Cristina Díaz Perlas i Dra. Vanesa Nozal García

24. Study of the anti-senescent capacity of exosomes in human normal dermal fibroblasts (HNDF)

Brief description and objectives: Replicative senescence is a phenomenon that occurs in adult cells once they have reached the maximum number of possible cell divisions, known as the Hayflick limit (Dr. Leonard Hayflick, 1960). This process is caused by the shortening of telomeres and factors that can produce genetic damage (oxidative stress and genotoxic agents), causing cells to lose their essential functions and accumulate in tissues, therefore promoting tissue failure that leads to aging. Although it has been proven that eliminating senescent cells from tissues using specific compounds, such as senolytic agents, promotes an increase in the proportion of normal cells and helps to increase tissue function, this way of combating aging can also accelerate it in the long term. In the first instance, the tissue will improve its function, but in the medium and long term, aging will accelerate. The reason is simple: by eliminating senescent cells with senotoxic agents, other neighboring non-senescent cells will necessarily enter cell division to maintain tissue mass and functional requirements, expending their proliferative capacity and generating general aging of the cell population.
There may be a solution to this paradox. In principle, if cellular mechanisms are activated to maintain the Hayflick limit low, despite the proliferative increase by non-senescent cells in the tissue, tissue rejuvenation would be generated without shortening its lifespan. These epigenetic mechanisms would generate cellular reprogramming that would cause, among other things, a transient activation of telomerase, which would maintain the telomeres of the chromosomes at their normal size, extending the regenerative capacity of the tissue.
At the Tissue Engineering Laboratory we are developing a new potential therapeutic platform based in the use of exosomes and three-dimensional microenvironments to promote reduction of the senescent proportion of dermal derived fibroblasts. We have observed significant non-senolytic reduction of senescence in fibroblast cultures and we are actively studying the possible mechanism of action.
Objective: The prospective TFG student will actively analyze by western blots and immunofluorescence the specific markers (up-regulated and down-regulated) of the senescence or anti-senescence process undergoing in the cell cultures. **Methodology:** molecular biology tools (wester blots), cell culture (immunofluorescence), tissue engineering (3D-cultures), etc.

Direcció: Dr. Carlos Semino

25. Desenvolupament i caracterització de nanopartícules funcionalitzades per a l'alliberament transdèrmic de material genètic terapèutic en models de càncer de mama metastàtic

Breu descripció i objectius: Partint de resultats previs del grup basats en sistemes de microagulles que permeten l'alliberament local i específic de material genètic terapèutic, aquest projecte té com a objectiu desenvolupar i caracteritzar noves formulacions de nanopartícules polimèriques funcionalitzades per a la seva aplicació transdèrmica. Aquestes nanopartícules estaran dissenyades per transportar material genètic terapèutic i alliberar-lo de manera selectiva en cèl·lules canceroses de càncer de mama metastàtic, amb l'objectiu de millorar l'eficiència del tractament i reduir-ne la toxicitat sistèmica.

Metodologies utilitzades: Síntesi i caracterització de nanopartícules polimèriques, estudis d'encapsulació i eficiència d'alliberament, anàlisi de la mida i potencial zeta, estudis d'estabilitat, i avaluació preliminar de la citotoxicitat. Optimització de la formulació per a la seva integració en sistemes de microagulles per a aplicacions transdèrmiques.

Direcció: Dra. Cristina Fornaguera Puigvert i Dra. Patricia González Sáenz

26. Optimization of Zwitterionic polymer-based coatings for Adeno-Associated Viral vectors toward a new therapy for Duchenne muscular dystrophy

Brief description and aims: Duchenne muscular dystrophy (DMD) is the most common and severe form of muscular dystrophy. It is caused by mutations in the X chromosome's DMD gene that encodes the dystrophin protein, an essential protein that stabilizes muscle fibers. Gene replacement using adeno-associated viral (AAV) vectors is one of the most promising therapeutic strategies currently under development. However, many patients have pre-existing anti-AAV antibodies due to natural exposure early in life, and immune responses become even stronger upon repeated vector administration. To solve pre-existing immunity issues, our group is developing an innovative approach based on coating AAVs with newly designed zwitterionic (ZW) polymers. These polymers include sulfobetaine groups carrying both positive and negative charges, resulting in overall neutral charge. The main advantage of this polymer is its high hydrophilicity, rendering it biocompatible in biological environments.
The aim of this Project (TFG) is to synthesize a short and a long ZW polymer and coat the AAVs along with and without muscle targeting peptides. The main objective is to define the ZW polymer that is offering the best coating efficiency. For this reason, the formation and stability of the coating, as well as the transduction efficiency in different cell lines will be studied.
Methodologies: Synthesis of the ZW polymers, functionalization with targeting peptides, AAV coating with ZW and purification, zeta potential measurements, cell culture of muscle and epithelial cells, transduction experiments, cell cytometry, confocal microscopy, cell viability assay

Direcció: Dra. Marta Guerra Rebollo

27. Comparison of covalent strategies for PBAE polymer attachment to AAV vectors and evaluation of coating efficiency

Brief description and aims: Duchenne muscular dystrophy (DMD) is a severe genetic disease caused by mutations in the dystrophin gene on the X chromosome. In the absence of dystrophin, muscle fibers progressively weaken, leading to severe disability and reduced life expectancy. A promising therapeutic approach is based on adeno-associated viral vectors (AAVs) to deliver a functional microdystrophin gene to muscle tissues. However, presence of neutralizing Ab makes AAvs re-administration challenging due to immune system recognition. To overcome this limitation, in our group, we have already developed Poly(β-amino ester) (PBAE) polymer coatings that can protect the viral capsid and improve transduction in muscle cells. We have found that covalent methods of polymer attachment to the viral capsid are preferred over non-covalent, but it remains unclear which covalent chemistry is best suited for viral attachment. In particular, two attachment strategies are under investigation, either NHS-ester chemistry or bio-orthogonal click chemistry.
The aim of this Project (TFG) is to study two parallel PBAE derivatives (with NHS reactive group or azide functionalization) and compare their coating performance on AAV vectors. The coated AAVs with both PBAE derivatives will be purified and their coating efficiency will be evaluated in cell transduction experiments.

Methodologies: Synthesis of the two PBAE derivatives, optimization of coating conditions for each chemistry, purification and characterization of coated and naked AAVs, cell culture of muscle and epithelial cells, transduction experiments, cell cytometry, cell viability assay

Direcció: Dra. Marta Guerra Rebollo

28. *Toxicity evaluation of different polymer coatings for Adeno-Associated Viral vectors using in vitro and in vivo methodologies*

Brief description and aims: Muscular dystrophies are a group of rare genetic disorders characterized by progressive muscle weakness and loss of function. One of the most clinical promising viral vectors for gene therapy are the adeno-associated viral (AAV) vectors, due to their safety profile and high muscle tropism. However, repeated systemic administration of naked AAV vectors triggers immune responses that reduce treatment effectiveness. Our group is developing multiple biocompatible polymer coatings that can shield AAV capsids, reduce immune recognition, and improve delivery efficiency. Before moving to advanced preclinical testing, we are interested to determine the biosafety profile of all the prepared polymer coatings (either alone or attached to AAVs) combining *in vitro* data from different cell lines as well as *in vivo* data based on a planarian model.
The aim of this Project (TFG), is to assess the toxicity of different polymers synthesized in the group and of polymer-coated AAVs using *in vitro* cell based assays and a simple, low-*cost in vivo* methodology based on planarians. By correlating both datasets, the overall aim is to establish easy and low-cost methodologies that can help predict future toxicity outcomes in mammalian studies.
Methodologies: Coating and purification of AAVs, Mammalian cell culture, Planarians culture, cell viability assay, brightfield imaging for morphological evaluation, data analysis for correlating *in vitro* and *in vivo* data

Direcció: Dra. Marta Guerra Rebollo i Dra. Loli Molina Jiménez

29. Multimodal Human–Computer Interaction: A Pilot Study on Integrated Physiological and Behavioural Responses to Sensory Stimuli

This pilot project aims to establish a multimodal human–computer interaction (HCI) framework that investigates how the human brain, heart, eyes, and motor behaviour respond collectively to sensory stimuli. Students will design and conduct a controlled experiment using PsychoPy, presenting visual and auditory stimuli while simultaneously recording EEG (OpenBCI 16-channel), eye movements (Gazepoint), cardiac and electrodermal signals (EmotiBit), and mouse tracking. The study will serve as a technical and methodological validation of the multimodal setup, focusing on synchronisation accuracy, data quality, and the feasibility of identifying cross-signal correlations.
The project's goal is to explore how these diverse signals co-vary during perception, attention, and motor control—revealing how different physiological systems respond as an integrated whole. Data will be synchronised using Lab Streaming Layer (LSL) and analysed to extract features such as EEG band power, heart rate variability, galvanic skin response, gaze patterns, and mouse dynamics. Students will then perform correlation and exploratory analyses to test whether low-cost behavioural and physiological signals can predict neural markers of engagement or arousal.
Programming experience in Python is required, and familiarity with signal processing or data analysis is advantageous. This pilot will generate preliminary data to refine the experimental paradigm and analytical methods for a larger study. Students will gain hands-on experience in multimodal data acquisition, synchronisation, and feature extraction, while contributing to the development of an

integrated system for studying human sensory processing and adaptive human–computer interfaces.

Direcció: Dr. Michael Bruyns-Haylett

30. Multimodal Feature Analysis for Emotion Recognition: A Machine Learning Approach Using EmoWear, DREAMER, and DEAP Datasets

This project will explore emotion recognition by comparing three publicly available datasets each providing unique insights from physiological and motion data to identify emotional states. By utilising these datasets, students will investigate common features across various modalities, such as ECG, EEG, EDA, motion data, and other physiological signals, to identify universal markers that correlate with emotional states across diverse contexts. EmoWear provides data from 49 participants watching emotionally evocative videos and performing tasks like walking, talking, and drinking, while DREAMER and DEAP focus on EEG and peripheral physiological signals in controlled emotional stimuli settings. Together, these datasets allow a comparative analysis of how different signals reflect emotional arousal, valence, and other affective dimensions.

Programming experience in either Python or MATLAB is necessary, as students will engage in data harmonisation and feature engineering across datasets to build a unified model for emotion recognition, testing the transferability of features like heart rate variability, skin conductance, accelerometer data, and EEG frequency bands. Using machine learning models, students will analyse which physiological indicators are most robust across datasets, enhancing their understanding of the physiological markers that contribute to consistent emotion detection across modalities. This hands-on approach provides students with valuable experience in both programming and applied machine learning while advancing insights into cross-modal emotional recognition.

Direcció: Dr. Michael Bruyns-Haylett

31. Validation of a protein-degrader nanotechnology released from a hydrogel wound dressing for the treatment of diabetic foot ulcers

Brief description: Diabetic foot ulcers (DFUs) are chronic, non-healing wounds characterised by excessive inflammation and tissue degradation driven by proteases such as matrix metalloproteinases (MMPs). Conventional wound dressings fail to modulate this pathological environment, resulting in delayed healing and frequent infection. Protein-degrader nanotechnologies offer a promising therapeutic strategy by selectively targeting and degrading pathogenic proteins that prevent tissue regeneration.
This project aims to validate a protein-degrader nanotechnology encapsulated in a biocompatible hydrogel dressing designed for sustained, local release. The system is engineered to reduce protease activity and inflammatory signalling while promoting fibroblast and keratinocyte viability. The work will involve the development of 2D in-vitro DFU models using diabetic fibroblasts and keratinocytes, followed by treatment with the hydrogel-nanoparticle system. Healing efficacy will be assessed through cell viability (live-dead assays), protease inhibition (zymography), and cytokine quantification (ELISA). Hydrogel formulations will be prepared and optimised for controlled release and biocompatibility.

Objective: Validate the therapeutic potential of a protein-degrader nanotechnology released from a hydrogel wound dressing by demonstrating its ability to reduce proteolytic activity and promote cellular viability in in-vitro DFU models.
Technical skills: Tissue culture, development of 2D in-vitro DFU models, hydrogel fabrication, nanoparticle encapsulation, ELISA, zymography, live-dead assays, microscopy, data analysis

Direcció: Dra. Núria Oliva Jorge i Dr. Jose Antonio Duran Mota

32. Bioprocess development for the production of cosmetic ingredients in Plant Stem Cells (VEG4COS)

Platform development for the biotechnological production of ingredients for cosmetic applications based on *in vitro* culture of plant stem cells as an alternative to extracting ingredients from plants' biomass, to produce anti-aging, anti-oxidants, and other ingredients with cosmetic activity.
The interest of companies focused on the production of cosmetic ingredients is moving fast from the classical ingredient extraction from plants to biotechnological-based bioprocesses that allow the no stationary production, improve reproducibility and product quality. The student will join a team of the project VEG4COS composed by 2 PhD candidates. The project has granted by Acció (Nuclis, Genralitat de Catalunya) in collaboration with Biogründl SL (https://biogrundl.es/), a well stablished company of the cosmetic ingredients sector.
Up to date, Plan Stem Cells have been induced from explants of the of the species of interest (*Ocimum basilicum*) and cultured in callus and in suspension. The final goal is to produce Flavonoids and Polyphenols and test their antioxidant and antiaging activity *in vitro* using hNDF (human fibroblasts).
The main aim is to stablish the bases of the bioprocess based on Plant Stem Cells at bench scale bioreactors (from shake flasks up to 5-liter Bioreactor). This work will include the study of the main culturing and bioprocessing conditions, the development of bioprocess monitoring tools, bioprocess intensification to increase productivities, and if possible, production of different batches of the ingredient of interest and its characterization.
The objective of this Final Degree Project is to explore the use of plant stem cells as a sustainable source of bioactive compounds for cosmetic applications. Starting from differentiated cell lines derived from explants, the project involves a process of selection and screening to identify the most resilient, fast-growing, and productive cell cultures. These selected lines will then be transferred to suspension cultures, where different elicitation methods will be tested to enhance the production of flavonoids and polyphenols. In the most promising cases, biochemical assays will be carried out to evaluate the antioxidant activity of the produced molecules, which will also be tested in an *in vitro* platform using human cell models (hNDF). The overall aim is to contribute to the development of innovative and environmentally responsible cosmetic ingredients through plant cell biotechnology.

Direcció: Dr. Martí Lecina Veciana i Dr. Pau Leivar Rico

33. Development of a platform to engineer small extracellular vesicles for peptide-based therapies targeting AAT deficiency

The working hypothesis is that small extracellular vesicles (sEVs) can serve as an efficient delivery system for therapeutic proteins and peptides, which can be endogenously loaded by engineering the donor cell lines. Specifically, the present proposal focuses on developing an innovative therapeutic approach that employs small extracellular vesicles (sEVs) as a delivery system for functional alpha-1 antitrypsin (AAT) to protect alveoli from enzymatic degradation in patients sulfureting of AAT deficiency. This innovative treatment can be administrated via inhalation, directly to the lungs.

Building on this hypothesis, the primary goal of the project is to design endogenous loading strategies by expressing recombinant fusion proteins composed of hATT and sEVs specific markers. To achieve this goal, the proposal identifies four milestones that address key challenges in the development of EV-based therapeutics: **a)** achieving efficient protein (AAT) loading on/into EVs, **b)** overcoming limitations in scalable and efficient EV purification methods, **c)** ensuring effective delivery of EVs to pulmonary tissue, and **d)** establishing a robust, scalable biomanufacturing process for EV production. To achieve this goal, we have defined three specific objectives:
The **first objective** focuses on the engineering of HEK293 cells to produce esEVs efficiently loaded with AAT. This objective involves the expression of AAT fused to LAMP2B or TSG101. The strategy includes the expression of cleavable HisTag/StrepTag on the esEV surface to facilitate esEVs purification.

This proposal belongs to the project **TherPeEVs** kindly founded by the Ministerio de Ciencia e Innovación (Plan Estatal de Investigación Científica y Innovación). The student will work within a research group together with a Polish PostDoc researcher, so a good level of English is essential.

Direcció: Dr. Martí Lecina Veciana

34. Development of a bioprocess platform for the large-scale production and purification of small extracellular vesicles (sEVs) derived from HEK293 cells

This Final Degree Project is part of the *TherPerEVs* project, funded by the *Ministerio de Ciencia e Innovación* under the *Plan Estatal de Investigación Científica y Técnica y de Innovación*. The overarching goal of *TherPerEVs* is to develop a therapeutic platform based on engineered small extracellular vesicles (sEVs) for peptide- and protein-based therapies targeting alpha-1 antitrypsin (AAT) deficiency. Within this framework, the proposed project focuses on the bioprocess development required for the efficient and scalable production of sEVs using HEK293 cell cultures.
The student will work on establishing and optimizing upstream and downstream processes, with special emphasis on the design and operation of high-density culture systems in bioreactors. The upstream phase will involve applying different process strategies—including *fed-batch*, *perfusion*, and intensified continuous culture modes—to enhance cell growth, productivity, and sEV yield. Process parameters such as nutrient feeding profiles, oxygen transfer, and shear stress control will be systematically studied to identify the optimal operating window.
In the downstream phase, the student will implement and evaluate a purification workflow based on a multi-step tangential flow filtration (TFF) cascade coupled to an affinity chromatography. This system will be designed to ensure efficient clarification, concentration, and polishing of sEVs while maintaining their structural and functional integrity. The ultimate aim is to integrate upstream and downstream operations into a consistent and scalable continuous manufacturing process.
Experimental work will be conducted using a prototype Single-Use Bioreactor (SUB) developed in collaboration with an industrial partner, offering the opportunity to work with state-of-the-art technology in process intensification and advanced biomanufacturing.
The project provides practical training in mammalian cell culture, bioreactor operation, process monitoring, and EV purification. The student will join the Bioprocessing Lab at the Department of Bioengineering, under the supervision of Dr. Martí Lecina, and will collaborate closely with a Polish postdoctoral researcher. Therefore, a good level of English is essential for effective communication and documentation.

Direcció: Dr. Martí Lecina Veciana

35. Process Design and Techno-Economic Analysis of a Manufacturing Platform for Small Extracellular Vesicles (sEVs)

The focus of the proposal is on the design and simulation of a large-scale manufacturing process for small extracellular vesicles (sEVs), using SuperPro Designer software as the main process modelling and analysis tool. Unlike experimental work performed in the laboratory, this dry-lab project aims to translate experimental data generated by the group over recent years together with data from the literature when needed, into a full-scale bioprocess model capable of identifying key process bottlenecks, critical components, and operational risks.
The student will design the overall process flowsheet, integrating upstream and downstream unit operations for sEV production and purification. Through dynamic simulation and mass-balance analysis, the project will identify key process limitations and propose optimization strategies to improve productivity, robustness, and cost-effectiveness. Sensitivity and risk analyses will be performed to evaluate how process parameters impact production efficiency and scalability.
A particular focus will be placed on assessing the economic sustainability of the process, estimating manufacturing costs, and exploring potential strategies for process intensification and continuous manufacturing. This work will provide valuable insights into the feasibility of industrial-scale sEV production—an emerging biopharmaceutical platform for which no commercial products currently exist. By quantifying process limitations and estimating production costs, the project aims to define the technological and economic boundaries that future EV-based therapeutics will need to overcome.
While not a requirement, the project is particularly suited for students who have taken the Bioprocess Simulation and Analysis elective course.

Direcció: Dr. Martí Lecina Veciana

DEPARTAMENT BIOENGINYERIA / DEPARTAMENT QUÍMICA ORGÀNICA I FARMACÈUTICA

36. Production of Vaults: a virus-like-particle with a lock-open mechanism allowing the cargo of therapeutical as a novel drug delivery system

Precision personalized medicine seek for next-generation biomaterials to serve as drug delivery systems with “smart” functional properties, including accurate recognition, self-organization and adaptability. Several strategies are currently inspired by the prospect of controlling the precise protein architectures as an alternative to the classic delivery systems. Among them, a particular virus like particles (VLP) named vaults represent a particularly attractive case, being about 40 nm -width-, 70 nm -length in size. Their natural function is not yet completely elucidated, although several functions related to nuclear transport, immune response, and drug multiresistance in cancer cells have been hypothesized. These nanocapsules are composed of different protein constituents and they can be produced in large quantities by expression of recombinant versions of the “major vault protein” (MVP) alone. Importantly, the vault particle represents an assembly of half-vaults. Under acidic conditions, the vaults can be reversibly opened and loaded with small molecules or biopharmaceuticals.
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, 70 nm -length in size. Their natural function is not yet completely elucidated, although several functions related to nuclear transport, immune response, and drug multiresistance in cancer cells have been hypothesized. These nanocapsules are composed of different protein constituents and they can be produced in large quantities by expression of recombinant versions of the “major vault protein” (MVP) alone. Importantly, the vault particle represents an assembly of half-vaults. Under acidic conditions, the vaults can be reversibly opened and loaded with small molecules or biopharmaceuticals.

Direcció: Dr. Martí Lecina Veciana i Dra. Ana Belén Cuenca González

37. Microscopy image of isolated Vaults, and vault 3D reconstruction

The project consists in engineering HEK293 (human cell line) to produce engineered vaults with improved functionalities for cell tracking, quantification and specific purification. Initially, heterologous expression of MVP protein will be performed in HEK293 cells, and then purified by SEC and characterized by means of cytometry, western blot, NTA (nano-tracking analysis) and cryo-TEM. Once purified, vaults will be loaded with a small reporter molecule to assess functionality and loading capacity. Then, vaults uptake by recipient wild-type HEK293 cells will allow the assessment of vaults functionality and the potential of vaults to be used as delivery systems. Once purified, Vaults can be loaded with drugs/mRNA, by taking advantage of the dynamics of the nanoparticle (can be opened by lowering the pH).

The second part of the project consists in modifying MVP protein expression by fusing eGFP to N terminus of MVP to provide a fluorescent labelling to vaults, and StrepTag to the C-terminus (located outside the cupula structure), what will ease vaults purification, tracking and quantification. Also targeting peptides will be fused to MVP to provide specific cell targeting to direct the drug delivery to specific recipient cells.

This piece of work will be conducted in collaboration with a PhD student and Dr Ana Belén Cuenca, head of Pharmaceutical Chemistry Department, whose team will further chemically modify the produced vaults to provide with improved features.

Direcció: Dr. Martí Lecina Veciana i Dra. Ana Belén Cuenca González

38. Design of Amisamide-Based Smart Polymers for Targeted Cancer Therapy and Their Integration into Therapeutic Hydrogels

This Final Degree Project focuses on the synthesis and characterization of functional polymers derived from amisamide, a ligand known for its cancer cell-targeting capability. These polymers will be chemically modified to enhance their biocompatibility and affinity toward specific membrane receptors. Subsequently, they will be incorporated into hydrogel matrices to create hybrid systems capable of localized mRNA delivery. The project combines polymer engineering, biomedical chemistry, and *drug delivery* design with potential applications in oncology.

Direcció: Dra. Cristina Fornaguera Puigvert i Dr. Carles Bofill Bonet

39. Low-dose insulin in dermatological formulations for skin regeneration and wound healing

This Final Degree Project focuses on the development of a dermocosmetic cream formulation containing low concentrations of insulin, aimed at evaluating its potential regenerative and wound-healing properties on superficial skin injuries. The study includes the in vitro assessment of insulin efficacy as a healing agent in human dermal fibroblasts (hDF), as well as the design, preparation, and physicochemical characterization of the topical formulation. Additionally, the stability and skin safety of the product will be investigated. This project seeks to provide an innovative approach to the use of bioactive pharmaceutical ingredients in topical products intended for skin repair and regeneration.

Direcció: Dra. Nuria Oliva Jorge i Dr. Carles Bofill Bonet

40. Molecular basis for targeted therapies

Brief description and aims: Most muscular dystrophies are rare genetic disease characterized by progressive muscle wasting and weakness. In this project, we are interested in assessing the targeting of novel therapeutic compounds to muscle cells by predicting their binding to target proteins. Molecular modeling methods have been widely applied to understand the mechanism of drug targets at molecular level. The aim of this project (TFG) is to apply structure-based approaches to study the molecular recognition between therapeutic agents and their corresponding cell receptors and use this information to design new molecular systems with better properties.
Methodologies: Molecular modeling, polymer synthesis, nanoparticle characterization.

Direcció: Dr. Roger Estrada Tejedor i Dra. Marta Guerra Rebollo

DEPARTAMENT BIOENGINYERIA / DEPARTAMENT QUÍMICA ANALÍTICA I APLICADA

41. Cultiu de cianobacteris (Microcystis aeruginosa) i seguiment de la producció de cianotoxines per HPLC-MS/MS

Els cianobacteris, o microalgues verdeblaves, són microorganismes fotosintètics que produeixen compostos bioactius de rellevància ecològica i biotecnològica com cianopèptids i cianotoxines. Gràcies al seu ràpid creixement, els seus baixos costos de cultiu i la possibilitat de desenvolupar-se en fotobioreactors tancats sense necessitat de sòl agrícola, els cianobacteris es perfilen com una eina clau en la biotecnologia ambiental i farmacèutica del futur.
En aquest TFG l'estudiant cultivarà soques productores de cianotoxines en un fotobioreactor de laboratori, controlant les condicions de creixement i monitoritzant la producció de microcistines i neurotoxines mitjançant tècniques analítiques HPLC-MS/MS. El projecte combina microbiologia, biotecnologia i sostenibilitat i ofereix una experiència pràctica en l'ús de microorganismes fotosintètics per a la investigació aplicada.
Aquest treball s'engloba dins del projecte ESCCAP finançat per l'Agència Catalana de l'Aigua.

Direcció: Dra. Maria Auset Vallejo i Dr. Xavier Ortiz Almirall

42. Estudio de los mecanismos de inactivación bacteriana mediante Terapia Fotodinámica

Los procesos de desinfección mediante especies reactivas de oxígeno (ROS) provocan la inactivación de bacterias y virus mediante mecanismos de (a) daño a la membrana o envoltura (b) inactivación de enzimas y proteínas esenciales; y/o c) daño oxidativo de los ácidos nucleicos.
Objetivo: En este TFG se estudiarán los mecanismos de muerte celular por irradiación mediante Terapia Fotodinámica para elucidar si el daño afecta a la integridad de la membrana externa o bien a los componentes internos de la célula.
Metodología: Las lesiones letales bacterianas resultantes de procesos con especies reactivas de oxígeno se analizarán mediante crecimiento en medios selectivos. La cuantificación de la salida de material nucleico de las células bacterianas se utilizará como indicador del daño de la membrana, mediante la tinción del ADN con SYTOX green como trazador de su destino.

Este TFG es experimental y supone pasar más del 70% del tiempo en el laboratorio.

Direcció: Dra. Maria Auset Vallejo i Dr. Santi Nonell Marrugat

DEPARTAMENT BIOENGINYERIA / ENGINYERIA QUÍMICA I CIÈNCIA DE MATERIALS

43. Development and characterisation of an electroconductive polymer–biopolymer hybrid hydrogel for wound healing and tissue regeneration

Brief description: Next-generation wound dressings aim not only to provide a physical barrier and hydration but also to actively stimulate tissue repair. Conductive hydrogels represent a promising platform by combining the softness and biocompatibility of natural polymers with the electrical properties of conductive polymers, enabling both biochemical and electrostimulatory modulation of cells involved in wound healing.
This project will focus on designing, synthesising, and characterising a hybrid hydrogel that integrates an electroconductive polymer (e.g. polypyrrole, PEDOT:PSS, or polyaniline) within a biopolymer matrix (e.g. gelatin, hyaluronic acid, or alginate). The formulation will be engineered to achieve controlled mechanical strength, swelling, degradation, ionic conductivity, and cytocompatibility suitable for skin tissue applications. Rheological and electrical characterisation will include measurement of storage and loss moduli, stress relaxation, impedance spectroscopy, and four-point probe conductivity.
The hydrogel microstructure will be analysed by scanning electron microscopy (SEM) and porosity quantification. Crosslinking density, polymer dispersion, and electrochemical stability will also be evaluated. Following optimisation, the hydrogel will be tested as a substrate for dermal fibroblast and keratinocyte culture to assess cell attachment, proliferation, and response to electrical stimulation. The study will include live–dead imaging, metabolic assays, and expression of genes associated with wound repair and extracellular matrix remodelling.
Objective: Develop and optimise a conductive polymer–biopolymer hybrid hydrogel with tunable mechanical, rheological, and electrical properties to support cellular adhesion and promote regeneration under electrical stimulation conditions.
Technical skills: Polymer synthesis, hydrogel formulation and crosslinking, rheology (storage/loss modulus, stress relaxation), impedance spectroscopy, conductivity measurement, SEM microstructural analysis, swelling/degradation kinetics, cell culture, live–dead and metabolic assays, gene expression analysis (qPCR).

Direcció: Dra. Núria Oliva Jorge i Dr. Robert Texidó Bartés

44. Development of viscoelastic hydrogels as cellular scaffolds for skin models

Brief description: The skin is a highly dynamic organ that acts as the primary barrier against the external environment. Reliable in vitro skin models are essential for studying wound healing, scarring, inflammation, and for testing new therapies without relying exclusively on animal models. A key challenge in generating physiologically relevant skin models is recreating the native extracellular matrix (ECM), which is soft, hydrated, and viscoelastic rather than purely elastic. This project focuses on developing and characterizing viscoelastic hydrogels as 3D cellular scaffolds for skin models. The hydrogel matrix will be formulated from biopolymers and tuned to reproduce the mechanical and rheological behaviour of native skin tissue. The scaffold will be evaluated for its ability to support relevant skin cell types (e.g. dermal fibroblasts and/or keratinocytes), maintain cell viability, and promote extracellular matrix deposition. The work will include hydrogel fabrication, mechanical and rheological characterisation (storage/loss modulus, stress relaxation), structural assessment, and in vitro assays to determine cell viability, proliferation, and gene expression related to skin function and remodelling.
Objective: Synthesis and characterisation of a conductive polymer-biopolymer hybrid, and formulation and characterisation of a conductive, biocompatible hydrogel that provides cellular electrical stimulation.
Technical skills: Polymer chemistry, hydrogel fabrication, rheology, cell culture, metabolic assays, PCR, electrical properties characterization, structural analysis.

Direcció: Dra. Nuria Oliva Jorge i Dr. Robert Texidó Bartés

45. Uso de planarias de agua dulce en ensayos de toxicidad para el monitoreo de la calidad de las aguas

Las planarias de agua dulce son gusanos planos de vida libre que se encuentran comúnmente en estanques y arroyos, reconocidas por su asombrosa capacidad de regeneración y plasticidad morfológica. Al ser organismos fáciles de cultivar en condiciones de laboratorio, las planarias son un modelo de prueba reconocido en la investigación de regeneración, biología del desarrollo y neurofarmacología, y debido a sus diversas respuestas a los contaminantes ambientales, han sido propuestas como bioindicadores valiosos de la calidad del agua.
En este proyecto de TFG, usted examinará el impacto de contaminantes ambientales y otros factores estresantes sobre la supervivencia, el comportamiento (incluida la alimentación y la actividad locomotora) y la capacidad regenerativa de las planarias.
Los contaminantes a evaluar incluirán principalmente sustancias perfluoroalquiladas y polifluoroalquiladas (PFAS) conocidos como “químicos eternos” por su extremada estabilidad, y que actualmente no se conoce de manera clara el posible efecto toxicológico que pueden tener en los humanos. La determinación de la toxicidad de estos compuestos en planarias permitirá el desarrollo de un modelo de toxicidad de gran utilidad para la comunidad científica.
Su trabajo analizará el efecto de los contaminantes del agua en el comportamiento de las células madre de la planaria y su impacto en la capacidad regenerativa del animal. Este proyecto de TFG aportará luz a la comprensión de los mecanismos de acción de los contaminantes a diferentes concentraciones (gradiente de concentración) y la influencia de factores bióticos y abióticos naturales sobre la toxicidad en el animal, así como ayudará a establecer las planarias como bioindicadores para el control de la calidad del agua en procesos de reutilización de agua.

Importante: El TFG es experimental y supone más de un 70% de trabajo en el laboratorio

Direcció: Dra. Loli Molina Jiménez i Dr. Yeray Asensio Ramírez

46. Development and characterization of human collagen-based bioinks for osteochondral tissue engineering

Brief Description: This project focuses on the development and optimization of human collagen-based bioinks for applications in osteochondral tissue regeneration. The student will explore different strategies to formulate printable biomaterials with suitable rheological and biological properties for use in 3D bioprinting.
Objective: To design, prepare, and evaluate human collagen-based bioinks by combining various materials and formulations, with the aim of achieving tunable mechanical, rheological, and biological properties suitable for 3D printing and biofabrication.
Methodology: The student will begin by exploring different strategies for formulating collagen-based bioinks, incorporating complementary biomaterials to modulate viscosity, printability, and stability. The rheological properties of each formulation will be characterized to assess their suitability for extrusion-based 3D printing. Selected formulations will be printed in 3D to evaluate print fidelity and structural integrity. In the later stages, cell-laden bioinks may be prepared and bioprinted to assess cell viability and distribution within the printed constructs. The collected data will help identify promising formulations for future osteochondral regeneration studies.

Direcció: Dr. Robert Texidó Bartés i Dra. Gloria Nieva Esteve

47. Design and experimental setup for cell evaluation of bone graft scaffolds in alveolar cleft repair

Brief description: Hospital Sant Joan de Deu has developed a methodology to personalize the alveolar scaffolds for cleft lip and palate, the most common maxillofacial malformation in newborns. Despite the personalization alveolar graft presents a 20% of clinical cases where osteointegration is not possible. This project involves the design and establishment of an experimental setup for the in vitro cellular evaluation of bone graft scaffolds intended for alveolar cleft repair in patients with cleft lip and palate. The student will develop the testing platform and perform biological assessments to determine how different scaffolds materials, shapes and architectures influence cell behaviour.
Objective: To design and implement an experimental system for evaluating cell–scaffold interactions, analysing cell adhesion, migration, and proliferation on various scaffold materials and designs, and to investigate how external mechanical stimuli may affect these responses.

Methodology: The student will begin by designing and assembling an in vitro testing setup suitable for the evaluation of different scaffold materials and geometries. Once established, the system will be used to culture relevant cell types on these scaffolds under controlled conditions. The project will include scaffold preparation and characterization, cell seeding, and subsequent analysis of cell adhesion, migration, and proliferation using fluorescence microscopy, viability assays, and image-based quantification. Additionally, if it's possible, mechanical stimulation experiments will be incorporated to study the influence of external mechanical cues on cellular responses. Finally, all collected data will be analysed to compare how material composition, scaffold design, and mechanical environment affect cell behaviour.

Direcció: Dr. Robert Texidó Bartés i Dra. Gloria Nieva Esteve

DEPARTAMENT BIOENGINYERIA / DEPARTAMENT DE MATEMÀTIQUES I ANALÍTICA DE DADES

48. From sequence to structure: evolutionary conservation at the active-site of carboydrate active enzymes

Brief description: The glycome is the entire complement of sugars, or glycans, found in an organism, cell, or tissue. It encompasses all glycan structures, including free oligosaccharides and those attached to proteins (glycoproteins) and lipids (glycolipids). Glycans play essential roles in various biological processes, including cell signaling, immune response, and pathogen recognition, and are often studied to understand disease mechanisms and develop therapies. At the Laboratory of Biochemistry, we are particularly interested in the enzymatic synthesis, degradation and reshaping of such glycan structures. There are millions of naturally occurring enzymes active on carbohydrates (Carbohydarte Active enZYmes, http://www.cazy.org/). In previous years we have initiated the development of an artificial intelligence model to predict substrate specificity in these families of enzymes.
Preliminary data indicates that the 3D structure of the active site of these enzymes holds part of the information that dictates substrate specificity in this family of enzymes. There is a concrete 3D arrangement of amino acid sidechains along the ligand binding pocket that allows the formation of specific enzyme-substrate interactions.
Objective: To analyze and quantify the sequence and structural conservation of CAZyme active-site pockets, revealing evolutionary patterns that shape substrate recognition and specificity.
Methodology: *Structural Bioinformatics. Programming and Data Analysis (R, Bash, TCL). More information:* link
Expected learning outcomes: You will integrate biochemical and computational approaches to gain insights into protein function and evolution. You will develop skills in data analysis, programming, and structural bioinformatics, which will strengthen your problem-solving and analytical abilities in biotechnology. Full-time dedicated.

Direcció: Dr. Xavier Biarnés Fontal i Dr. Francesc Martori

49. Shape-Based Analysis of Protein–Carbohydrate Recognition Sites

Protein–carbohydrate interactions play a key role in many biological processes, including immune recognition, infection, and cancer. Yet, the structural complexity of glycans makes it difficult to study how proteins recognize them. This project aims to develop computational methods to identify and classify glycan-binding sites based on the geometric properties of protein surfaces. The approach will analyze the surface patches around known monosaccharide binding sites, compute curvature and geometric descriptors, and represent them using simplified shape coefficients. By clustering proteins in this reduced geometric space, we will explore whether glycan-binding sites share distinctive surface features. Combining structural bioinformatics, mathematical modeling, and machine learning, this work will contribute to understanding the molecular basis of glycan recognition and may guide future applications in biotechnology and biomedicine.

Direcció: Dr. Giovanni Dalmasso i Dr. Xevi Biarnés Fontal

DEPARTAMENT QUÍMICA ANALÍTICA I APLICADA

50. Development of Topical Formulations for Treating Infections Using Photodynamic Therapy

Antimicrobial Photodynamic Therapy (aPDT) is a non-invasive phototherapy technique that uses a harmless light source to activate a photosensitizing agent. Once activated, this agent produces cytotoxic reactive oxygen species capable of inactivating pathogenic microorganisms. Although aPDT is not considered a first-line treatment for infections, its high selectivity, localized action, and multi-target mechanism make it an attractive alternative to conventional therapies.
Recently, materials exhibiting the phenomenon known as Cluster Triggered Emission (CTE) have been discovered. These materials emit light under aggregation conditions and can act as photosensitizers. In our laboratory, we have studied their photochemical properties and their ability to photoinactivate bacteria. This opens the door to a new challenge: developing commercially viable formulations that maintain photosensitizing activity while meeting stability requirements, an essential step toward real-world applications.
As part of this project, the student will explore different formulations, aiming to identify those that preserve photosensitizing activity and exhibit adequate stability. Finally, the student will test the antimicrobial performance of these materials using photodynamic technology.

Direcció: Dr. Roger Bresoli Obach i Dr. Santi Nonell Marrugat

51. Evaluation of the photoantitumoral activity of different photosensitizers for cancer treatment under hypoxia condition

Photodynamic therapy (PDT) has emerged as an innovative approach to eliminate viruses, photogenic microorganisms and prejudicial tumoral cells, reducing side effects and without the resistance emergence dangers. PDT involves molecular oxygen, light and a chromophore, so-called photosensitizer (PS), to cause cell death. Although its promising potential, PDT efficiency drops under hypoxia conditions (< 2% O2) due to the conventional mechanism of PDT. During this work, the candidate will evaluate the efficacy of a new type of photosensitizer with a different working mechanism that its efficiency should be less dependent with oxygen concentration for antitumoral PDT.

Direcció: Dr. Roger Bresoli Obach i Dr. Santi Nonell Marrugat

52. Determination of hydroxyl radical production from water oxidation in biological environments

Photodynamic therapy has emerged as an innovative approach to current chemotherapy or surgery approaches for inactivating prejudicial cancerous cells as well as pathogenic microorganisms. In addition, PDT have other positive aspects as reducing side effects and avoiding the resistance appearance. Currently, PDT involves molecular oxygen, light and a chromophore, so-called photosensitizer (PS), to cause cell death. However, this strategy may fail under severe hypoxia conditions.
We recently developed an alternative approach where cytotoxic species are generated through water (photo)oxidation. To support this mechanism, the proposed project aims to develop a new methodology for detecting and characterizing the chemical structure of those generated cytotoxic species. The candidate will explore trapping them using suitable chemical acceptor(s) and analyzing

the adducts via HPLC-MS. In a final step, isotopic labeling of water ($H_2{}^{18}O$) could prove that the detected cytotoxic species originate from water photooxidation.

Direcció: Dr. Roger Bresoli Obach i Dr. Santi Nonell Marrugat i Dra. Margalida Artigues Cladera

53. Diseño e implementación de una práctica de laboratorio de termodinámica y cinética basada en la calorimetría de la descomposición del peróxido de hidrógeno catalizada por catalasa

Este Trabajo de Fin de Grado tiene como objetivo el diseño, desarrollo y validación de una práctica experimental para el laboratorio de Termodinámica y Cinética (1r curso de Biotecnología), centrada en el estudio de la reacción exotérmica de descomposición del peróxido de hidrógeno (H_2O_2) catalizada por la enzima catalasa. La actividad se abordará desde una perspectiva termodinámica, utilizando técnicas de calorimetría para cuantificar el calor liberado durante la reacción. La propuesta busca integrar conceptos clave de cinética química, termodinámica y bioquímica, ofreciendo al alumno una experiencia práctica interdisciplinar. Además, se evaluará la viabilidad didáctica de la práctica, su reproducibilidad, y su adecuación a los recursos disponibles en el laboratorio docente.
Tiene los siguientes objetivos específicos: i) Diseñar un protocolo experimental seguro y reproducible para medir el calor de reacción mediante calorimetría; ii) Estimar la entalpía de descomposición del H_2O_2 en presencia de catalasa; iii) Analizar la influencia de variables como la concentración de sustrato o la temperatura sobre la energía liberada; y iv) Evaluar la aplicabilidad de la práctica como herramienta docente en el contexto de la enseñanza de la química física.
Tiene prevista la siguiente metodología: i) Revisión bibliográfica sobre calorimetría y reacciones enzimáticas; ii) Diseño del montaje experimental utilizando calorímetros de bajo coste o de laboratorio estándar; iii) Realización de ensayos preliminares para ajustar condiciones experimentales; iv) Análisis de datos y comparación con valores teóricos; y v) Redacción de una guía docente para su futura implementación.

Direcció: Dr. Roger Bresoli Obach i Dra. Mª Victoria Codera Pastor

54. Metallodrugs in phototherapies. Analysis of drug uptake by cells

Light-based disinfection processes cause the inactivation of bacteria and viruses through mechanisms such as (a) damage to the membrane or envelope, (b) inactivation of essential enzymes and proteins, and/or (c) oxidative damage to nucleic acids. For this, it is essential that the drugs are internalized by the microorganisms.
In this Bachelor's Thesis, an analytical technique will be developed to quantify the incorporation of metallodrugs into bacteria.
The project will involve learning how to perform bacterial cultures, learning photodynamic therapy, and using state-of-the-art ICP-MS equipment to quantify metals in bacteria. ICP-MS is one of the most sensitive techniques for trace metal quantification. In this project, it will be used to quantify the total metal internalized by the bacteria, and additionally, the new Single Cell-ICP-MS module will be used to obtain information on the metal content at the single-cell level.

Direcció: Dra. Ariadna Verdaguer Ferrer, Dra. Maria Auset Vallejo i Dr. Santi Nonell Marrugat

55. Development of a model of Parkinson's disease in zebrafish: neuropeptidomics

The dopaminergic system mediates several important brain functions, including motor activity. In humans the degeneration of dopaminergic neurons in the substantia nigra results in the depletion of dopamine (DA) in the striatum, which is associated with a group of movement disorders called parkinsonian syndromes, including idiopathic Parkinson's disease (PD). Epidemiological studies suggest that the exposure to pesticides is a risk factor for PD. While the ability of pesticides to induce PD has only been demonstrated for rotenone, paraquat, maneb, it is believed that these 3 pesticides may only be the tip of the iceberg (see OC/EFSA/PREV/2023/01). In addition to the pesticides, occupational exposure to certain metals, most notably iron and manganese, PCBs and brominated flame retardants has been also associated with an increased risk of parkinsonism. Chemical models of PD have been developed in different animal species, including vertebrates (rodents, non-human primates, fish, etc) and invertebrates (drosophila, Caerorhabditis elegants…). These chemical models of PD are based on degeneration of dopaminergic neurons induced by the administration of specific neurotoxic compounds targeting mitochondrial complex I [MPP+, rotenone, 6-OHDA] or generating oxidative stress (paraquat, maneb). For the two aquatic species considered in this proposal, face validity for the zebrafish models of PD have been conducted deficiently and Daphnia magna have not been considered yet.
Neuropeptidomics refers to the identification, characterization, and quantification of neuropeptides, defined as all those peptides secreted from neuronal tissues and/or signaling molecules involved in regulatory functions and behavioral control in the nervous system. Thus, neuropeptidomics aims to understand the roles of these neuropeptides in normal brain function, as well as their involvement in various neurological and psychiatric disorders. However, this process is extremely challenging due to neuropeptides are spatially, temporally, and chemically heterogeneous, making them difficult to predict in silico from genomic information. In this sense, LC coupled to MS is the most used technique in the study of targeted and non-targeted peptidomics. LC allows separation of the complex samples and MS offers structural information about the analytes. All this connected to bioinformatics, to give meaning to the analytics results.

Direcció: Dr. Cristian Gómez Canela

DEPARTAMENT QUÍMICA ANALÍTICA I APLICADA / DEPARTAMENT ENGINYERIA QUÍMICA I CIÈNCIA DE MATERIALS

56. Structural characterization of collagen for bioink design in cartilage regeneration

Summary: The field of regenerative medicine is increasingly focusing on the development of biomaterials that can closely mimic the structure and function of native tissues. One promising direction involves the use of bioinks enriched with collagen, a key structural protein essential for tissue integrity and regeneration. To optimize bioink design for cartilage repair, a deep understanding of collagen molecular structure and its crosslinking patterns is required. In this context, the present project focuses on the application of an advanced analytical strategy based on ultra-high-performance liquid chromatography coupled with quadrupole time-of-flight mass spectrometry (UHPLC-QTOF). The method will be used to determine and characterize collagen structural variants and post-translational modifications obtained from different biological sources and processing conditions. By integrating non-targeted and targeted analytical approaches, this work aims to identify key molecular features that influence the mechanical and biological properties of collagen-based bioinks.
The outcomes of this study will provide valuable insights into the relationship between collagen

structure and bioink performance, contributing to the rational design of next-generation biomaterials for cartilage regeneration and broader tissue engineering applications.
Laboratory: IQS–Sciex Demo Lab, Analytical and Applied Chemistry Department and Advanced Materials Lab, Chemical Engineering and Material Science Department.

Direcció: Dra. Margalida Artigues Cladera i Dr. Robert Texidó Bartés

DEPARTAMENT QUÍMICA ORGÀNICA I FARMACÈUTICA

57. Aplicació pràctica del procés d'Stöber

En aquest treball es proposa preparar nanopartícules de sílice mesoporosa amb diferents tipus de funcionalització i mida per ser utilitzades en l'obtenció de sistemes d'alliberament de fàrmacs. Es requereix un excel·lent nivell de Química Orgànica tan teòric com experimental.

Direcció: Dr. David Sánchez García

58. Molecular Design by Scaffold Hopping Strategy Towards the Identification of New Protein Kinase Inhibitors

Kinases are one of the most important human protein families and are directly or indirectly involved in all cellular biochemical pathways. Since early 2000s, 88 kinase inhibitors have entered in the clinics, representing a remarkable success story in drug development. However, there is still large number of unexplored kinases which have a strong genetic link to disease but poorly biology understood (see https://doi.org/10.1021/acs.jmedchem.1c00980).
Through a systematic computational study, in this project the student will replace the central chemical core of known kinase inhibitors with a variety of other heterocyclic rings, aiming to achieve an improved molecular affinity and selectivity towards the selected target kinase.
Here we are looking for very motivated students to work in the molecular design lab modelling new protein kinase inhibitors. The results could potentially provide a valuable foundation for future Medicinal Chemistry programs in different therapeutic fields.

Direcció: Dr. Roger Estrada Tejedor i Dr. Ricardo A. M. Serafim

59. I want it all! Development of cheminformatic models for the identification of dual inhibitors against key proteins in DLBCL

Diffuse large B cell lymphoma (DLBCL) is the most common form of adult lymphoma. Data gathered in the last decade have identified selective inhibitors for key proteins in DLBCL. This project aims to contribute to the development of new prediction models to allow the identification of dual inhibitors against target proteins by AI-assisted ligand-based drug design methodologies (+info). Programming skills are recommended but not mandatory.

Direcció: Dr. Roger Estrada Tejedor

DEPARTAMENT QUÍMICA ORGÀNICA I FARMACÈUTICA / DEPARTAMENT ENGINYERIA INDUSTRIAL

60. Development of a Sustainable Solid Perfume

This Final Degree Project focuses on the formulation and design of a solid perfume aligned with the principles of sustainable cosmetics. The work involves the selection and blending of natural, ethically sourced essential oils to create a fragrance, the development of a solid base using biodegradable and skin-safe excipients, and the conception of environmentally responsible packaging made from recyclable or compostable materials. The project follows a holistic and responsible innovation approach, ensuring that every stage -from ingredient sourcing to final presentation - adheres to sustainability, ethical production, and environmental preservation standards

Direcció: Dr. Carles Bofill Bonet, Dr. Giovanni Gómez Gras i Sr. Luca Caprera

DEPARTAMENT DE MATEMÀTIQUES I ANALÍTICA DE DADES

61. Anàlisi de dades single-cell

El desenvolupament de noves tècniques que permeten mesurar l'expressió genètica al nivell d'una única cèl·lula representa un gran avanç per a la comprensió dels mecanismes de regulació que utilitzen les cèl·lules per adaptar-se a les diferents funcions que duen a terme. Grans quantitats de dades s'estan generant per tot tipus de sistemes. El repte ara és analitzar i interpretar aquestes dades per tal d'avançar en la comprensió d'aquests mecanismes.

Aquest TFG proposa explorar dades *sc-RNA seq* tant per entendre les seves limitacions com el seu potencial. En concret, s'ha postulat que en sistemes de desenvolupament embrionari certes correlacions entre gens i cèl·lules es poden observar quan una població de cèl·lules canvia d'estat. L'objectiu final del treball serà posar a prova aquesta hipòtesi.

Direcció: Dra. Meritxell Sáez Cornellana

62. Simulació estocàstica de reaccions bioquímiques

Les interaccions entre proteïnes dins d'una cèl·lula es poden modelar utilitzant un graf que mostri els reactius i els productes de les diverses reaccions que hi tenen lloc. L'evolució temporal en el recompte de les diferents espècies de proteïnes es pot entendre com una equació diferencial discreta. Cada espècie de proteïna correspon a una variable. Com que el recompte d'aquestes proteïnes és baix, la seva evolució no és determinista si no que té un alt grau d'aleatorietat i es pot simular en un context estocàstic.
L'objectiu d'aquest TFG és la implementació d'un algorisme que permeti simular un conjunt de reaccions bioquímiques i analitzar l'efecte del recompte total de proteïnes, dels paràmetres que controlen la velocitat de les reaccions i del tipus de soroll considerat en l'evolució temporal del sistema i en l'assoliment d'un punt d'equilibri.

Direcció: Dra. Meritxell Sáez Cornellana i Dr. Jordi Cuadros Margarit

63. Aplicació de la Descomposició en valors singulars en la Biotecnologia

La descomposició en valors singulars (SVD, per les seves sigles en anglès) d'una matriu, real o complexa, és una factorització d'aquesta com a producte de tres matrius: dues d'elles ortogonals i una de diagonal amb valors no negatius a la diagonal. La SVD s'utilitza, entre altres aplicacions, per analitzar grans conjunts de dades i permet reduir la dimensionalitat, filtrar dades sorolloses i extreure patrons. En aquest treball es proposa estudiar les bases teòriques de la SVD, explorar els diversos usos en biotecnologia i analitzar alguna contribució científica en què aquesta metodologia ha estat rellevant

Direcció: Dra. Teresa Cortadellas Benítez i Dr. Sergi Novell Masot