Research Topics
PhD Programme in Biosciences

DIPARTIMENTO DI BIOLOGIA
UNIVERSITÀ DEGLI STUDI DI PADOVA

Research Topics XLI cycle
2025-2026

Below are the descriptions of all projects considered as priorities for the XLI cycle. Candidates are encouraged to identify at least one project of interest and mention it in the research statement to be uploaded with their application. For further details regarding the required documents for the application, please refer to the FAQ section available on the PhD Programme's website.

Curriculum Biochemistry and Biotechnology

Funded by External Public or Private Bodies/Departments

Impact of diet on mitochondrial contactome and its relevance in cancer.
Contact: Prof. Luigi Leanza, luigi.leanza@unipd.it

Mitochondria are important organelles not only involved in cellular respiration but also other processes ranging from cell life to cell death. To accomplish these functions, mitochondria are not isolated within the cells but are closely interconnected with other organelles. The dynamic regulation of mitochondria contact sites affects mitochondrial physiology and adaptation of cellular metabolism to nutrient availability. These sites of physical interactions are important hubs for signalling pathways, finally affecting tumor development. The project will shed light on the impact of diet on number and the architecture of contact sites and their involvement in cancer development and progression, to possibly identify new oncological targets and new possible treatment regimens, with a considerable outcome on patient's life expectation.

Exploring mitochondria and lipid droplets crosstalk in metabolic disease: a special focus on Ca2+ signalling and inflammation in adipocytes.
Contact: Prof. Marisa Brini, marisa.brini@unipd.it

The PhD project aims to undertake a comprehensive study on the mitochondria and lipid droplets interactions in adipocytes, leveraging both 3T3-L1 cells and mouse or human primary cultures. Metabolic alterations observed in obesity such as hyperglycemia and high free fatty acids/triglycerides, alongside inflammatory stimuli will be mimicked in cell cultures.
The PhD student will focus on the characterization of the contacts occurring between mitochondria and lipid droplets in adipocytes applying split-GFP-based contact site sensors (SPLICS)* and high-resolution imaging. Molecular tools to investigate the interactions and regulatory mechanisms governing the dynamic interplay between mitochondria and lipid droplets within the cellular environment and its implication across various cellular processes, including mitochondria function, lipid metabolism and inflammatory pathways will be

employed. The PhD student will also explore the impact of genetic and pharmacological modulation of mitochondrial Ca2+ handling on mitochondria and lipid droplets tethering and the role of adipocytes/macrophages crosstalk with the possibility that the modulation of mitochondrial Ca2+ handling could represent a valuable target for mitigating the inflammatory response in dysfunctional adipocytes.
Mitochondrial function in living adipocytes will be assessed by imaging mitochondrial calcium and membrane potential, ATP and ROS production, under different genetic and metabolic conditions of mitochondria and lipid droplets contact sites manipulation.

* PubMed: PMID:38374070; PMID: 34686857; PMID: 33247103
# In your application please select the option that you are interested in this specific project.

Network and quantitative biology: aspects of biochemistry and biotechnologies

For the topic of this project please refer to any of the projects Funded by the University reported below.

Funded by the University

Unravelling the role of key regulatory proteins in plant stress response and autophagy.
Contact: Prof. Alessandro Alboresi, alessandro.alboresi@unipd.it

Understanding the regulation of energetic metabolism is crucial for elucidating key physiological processes in plants. This project aims to investigate molecular mechanisms that influence energy homeostasis in the bryophyte Physcomitrium patens. Special attention will be given to autophagy-related factors and their impact on bioenergetic function. Advanced biochemical, cell biology and proteomic/transcriptomic approaches will be used to dissect their role in central metabolism. Experimental strategies will include mutant isolation and analysis, proteomic/metabolic profiling, and fluorescence-based assays. By studying P. patens as a model, this research may reveal unique adaptations of early-diverging land plants. The findings will also contribute to a broader understanding of conserved regulatory networks across kingdoms.

Harnessing Purple Bacteria for Lignin Recovery and Valorization: a biotechnological approach.
Contact: Prof. Francesco Filippini, francesco.filippini@unipd.it

This PhD project aims to explore the potential of purple bacteria for the sustainable recovery and valorization of lignin, a complex biopolymer found in plant biomass. Purple bacteria, known for their unique photosynthetic capabilities and versatile metabolism, will undergo comparative in silico and wet lab investigation for their potential and ability to degrade and metabolize lignin, a major byproduct in lignocellulosic biomass processing. In addition to comparative analyses to identify candidate enzymes, different byproducts of lignin treating processes will be tested, including sulphonate lignin and the one after hydrothermal treatment. A deeper investigation of the enzyme involved in the lignin degradation, in particular those related to the β–O–4′ bond, will be carried out, assessing the potential of enzyme evolution by computation-driven engineering. The possibility of using engineered microbial consortia will be also assessed. By optimizing both cultivation conditions and genetic approaches, this research seeks to enhance the efficiency of lignin breakdown into valuable chemicals. The project will also assess the environmental impact and economic feasibility of using purple

bacteria for lignin valorization, contributing to the development of greener, more efficient biotechnological processes for bioenergy and chemical production.

Investigating Single-Cell Signaling Pathways in Rice Root Plasticity Under Salt Stress.
Contact: Prof. Elide Formentin, elide.formentin@unipd.it

Roots are essential for water and nutrient absorption in plants and are the first to encounter soil-borne stresses like salinity. While genetically regulated, root architecture shows significant plasticity in response to environmental cues, aiding in acclimation to high salinity (Formentin et al., 2018). Calcium (Ca^{2+}) and reactive oxygen species (ROS) are key messengers in developmental responses to salt stress. Our findings in rice seedlings show that Ca^{2+} and ROS signaling are coordinated and contribute to salt tolerance. However, single-cell responses in different root layers remain poorly understood. This project aims to unravel the single-cell dynamics of Ca^{2+} and ROS signaling in rice root meristems, using genetically encoded probes for in vivo imaging and cutting-edge single-cell approaches. The Ph.D. student involved in this project will work in a dynamic and interdisciplinary research environment, collaborating with internationally recognized experts in the field.

Unlocking Mitochondrial Translation Control to Attack Triple-Negative Breast Cancer.
Contact: Prof. Maria Eugenia Soriano, mariaeugenia.soriano@unipd.it

Triple-negative breast Cancer (TNBC) remains one of the most aggressive and therapeutically challenging subtypes of breast cancer, marked by limited treatment options and poor clinical outcomes. Identifying novel, specific molecular targets is critical to advancing treatment strategies. This proposal aims to establish mitochondrial translation as a previously unrecognized vulnerability in TNBC by focusing on a mitochondrial protein we have identified as a key regulator of mitochondrial metabolism. Our findings indicate that this protein inhibits mitochondrial translation, promoting a metabolic shift toward glycolysis—a feature commonly associated with aggressive TNBC phenotypes. By targeting this protein with specifically designed antipeptides, we aim to restore mitochondrial function and oxidative metabolism, thereby reducing tumor aggressiveness and enhancing sensitivity to chemotherapy. The impact of this project is twofold: (1) it offers proof of concept for this mitochondrial protein as a promising therapeutic target in TNBC, paving the way for new drug development, and (2) it introduces a novel metabolic reprogramming strategy to improve the effectiveness of current treatments. If successful, this research could lead to innovative therapies that significantly improve survival and quality of life for patients with TNBC.

Pharmacological modulation of mitochondrial dysfunction.
Contact: Prof. Ildikò Szabò, ildiko.szabo@unipd.it

Mitochondria are crucial signaling and energetic hubs in the cells. Dysfunction of mitochondria leads to a variety of diseases ranging from cancer to mitochondrial and neurodegenerative diseases. The project focuses on mitochondrial dysfunction linked to defective ion homeostasis and respiratory chain complexes and on the connection between these two factors. State of the art tools will be exploited to dissect the molecular consequences and the signaling pathways related to these dysfunctions and novel pharmacological tools will be assessed during the Ph.D. project in order to rescue the defective phenotypes.

Beyond the collective: microbial investigation through high-resolution single-cell analytics.
Contact: Prof. Laura Treu, laura.treu@unipd.it

The diversity and activity of microbial isolates and populations are paramount for understanding the heterogeneity that characterizes them, especially concerning the complexity of anaerobic microbiota. Despite being very informative, meta-omics have some limitations hampering a complete understanding of their collective behavior. Single-cell technologies enable in-depth study of this diversity, utilizing microfluidic techniques for droplet encapsulation of individual cells. This approach offers new perspectives in understanding microbial metabolism and activity dynamics, revealing details at an unprecedented level. Specifically, studies of strains in microbiota at transcriptomic level are still in their infancy; therefore, this Ph.D. project will have a strong methodological component for developing these aspects.

Plant adaptation to changing environmental conditions.
Contact: Prof. Michela Zottini, michela.zottini@unipd.it

Rapid climate change increasingly exposes plants to novel environmental conditions that are outside of their physiological limits and beyond the range to which they are adapted and that compromise plant survival and productivity. For this reason, it is of primary importance to better understand the cellular and molecular processes that are involved in environmental stress response. In this context organelles play a major role. Mitochondria and plastids are indeed the powerhouse of the cell and important hubs with essential metabolic processes occurring within the organelles and several other pathways either emanating from or converging on them. Recent studies have pointed to mitochondria and plastids as important environmental sensors, capable of perceiving stressful conditions and triggering gene expression, epigenomic, metabolic and phytohormone changes in the plant. These processes involve integrated gene networks that ultimately modulate the energy balance between growth and plant defense. Properly functioning mitochondria, indeed, can be seen as an early checkpoint before cells commit to any developmental or stress-response processes. Maintenance of organelle integrity, in term of functionality, morphology and dynamics, crucial for cellular homeostasis and proper responses to environmental challenges, is provided through anterograde and retrograde signaling. This PhD project aim to identifying the molecular components and pathways that act as signals between the organelles and the nucleus, by using an integrated molecular, physiological, and imaging approach. In the last part of the project the gained knowledge we will exploit and transferred to an agronomical relevant crop, such as rice.

Positions without scholarship

Immunometabolism in melanoma: the role of transglutaminase type 2.
Contact: Prof. Luigi Leanza, luigi.leanza@unipd.it

Tissue transglutaminase type 2 (TG2) is a multifunctional enzyme important for cell growth and survival. Recent research highlights its crucial role in melanoma progression, where high TG2 levels correlate with increased melanoma cell proliferation. Reduced TG2 expression leads to larger and paler metastases, emphasizing its significance in cancer aggressiveness. The present project aims to correlate TG2 expression with immune cell recruitment and activation in melanoma. Immunometabolism, the merging of metabolism and immunity, is fundamental for an effective response against tumor cells. Therefore, a link between TG2

expression, cell metabolism, and immune system, will potentially improve targeted therapies against melanoma progression, finally impacting on patient survival.

Unravelling the impact of endothelial cells deregulation on tumor development.
Contact: Prof. Luigi Leanza, luigi.leanza@unipd.it

Transglutaminase Type-2 (TG2) is a ubiquitously expressed protein which structural and functional characteristics make it object of intense studies in cancer biology. Endothelial cells, under specific tumoral stimuli, adapt their parameters of migration, tubule formation and duplication to face the tumour's needs. This project aims to study the role of TG2 in endothelial cells behavioural mechanisms in tumoral context. Through in vitro and in vivo experiments, this project will focus on highlighting the potential role of TG2 as a target for anti-cancer therapies via its regulation during angiogenesis. Growing awareness is spreading about the importance of the tumour's surrounding context in influencing cancer development. Therefore, the impact of finding common regulatory mechanisms for processes, such as angiogenesis modulation, in different tumour types will be fundamental.

Curriculum Cell Biology and Physiology

Funded by External Public or Private Bodies/Departments

Seeding and sorting of intramitochondrial protein aggregates.
Contact: Prof. Luca Scorrano, luca.scorrano@unipd.it

Quality control processes maintain mitochondrial health, enabling cellular functions including bioenergetics, metabolism, Ca2+ signaling, and cell death regulation. Mitochondrial proteases, unfolded protein response, asymmetric fission, vesicle shedding, and mitophagy all contribute to organelle quality. However, the specific triggers for these processes remain unclear. While unfolded protein accumulation appears to be a common event preceding these diverse responses, the mechanism by which it initiates them remains uncertain. By using the advanced tools for real-time imaging of protein aggregation in mitochondrial subcompartments developed in the lab, the successful candidate will use advanced imaging techniques, biochemistry, functional assays, to decipher the rules governing aggregate formation, seeding and sorting.

Role of metabolism in angiogenesis and cancer progression.
Contact: Prof. Massimo Santoro, massimo.santoro@unipd.it

Endothelial and tumor cells exhibit unique plasticity regarding redox biology and metabolism. Our lab has contributed to decoding some of these cellular and molecular mechanisms in the past years. By using advanced redox and metabolic platforms, and innovative molecular and genetic approaches in cellular and animal models, we aim to shed light on the role of novel metabolic pathways and enzymes in angiogenesis (developmental vs pathological) and cancer disease (melanoma). The ultimate objective is to develop innovative therapeutic strategies and complement existing ones based on genetic and pharmacological manipulation of redox and metabolic state in angiogenic and cancer processes.

Analysis of diet-induced epigenetic reprogramming in pancreatic cancer evolution.
Contact: Prof. Alessandro Carrer, alessandro.carrer@unipd.it

As therapeutic options for pancreatic ductal adenocarcinoma (PDA) are limited, prevention remains critical to curtail cancer-related deaths. Lifestyle factors account for elevated incidence in Western countries and offer an opportunity to intercept the disease. Among these,

both epidemiological and experimental evidence indicate that elevated fructose intake promotes PDA, but mechanisms are elusive.
Our previous work showed that dietary fructose feeds acetyl-CoA metabolism through its conversion into acetate by the gut microbiome. In an orthogonal study, we found that acetyl-CoA also supports pancreatic tumorigenesis, by dictating levels of protein acetylation. Preliminary data show that fructose intake accelerates pancreatic tumorigenesis in autochthonous mouse models and induces changes in protein acetylation.
The PhD candidate will interrogate top hits we obtained in an acetyl-proteomic screen to dissect their metabolic-dependent acetylation and the impact of fructose intake on their expression and/or function. Special focus will be placed on histone proteins and how diet-dependent acetylation may elicit oncogenic programs.
The candidate will perform classical biochemistry assay for protein analysis (Western blotting, immuno-staining, protein purification combined with mass-spectrometry) and advanced molecular biology techniques for the mapping of epigenetic/transcriptomic reprogramming. The PhD candidate will work with both mammalian cell cultures and animal models.

Network and quantitative biology: aspects of cell biology and physiology

For the topic of this project please refer to any of the projects Funded by the University reported below.

Funded by the University

Phagocytic role of astrocytes: unveiling molecular signatures and crosstalk with microglia in neurodegenerative diseases.
Contact: Prof. Laura Civiero, laura.civiero@unipd.it

Background: Multiple neurodegenerative disorders are characterized by the presence of intra- or extra-cellular protein aggregates. The intraneuronal aggregates can be released in the external environment via exocytosis or due to neuronal death. The clearance of these aggregates from the extracellular environment is essential to limit spreading and neuroinflammation. The removal is mediated by phagocytic cells, in the first place by microglia. Nevertheless, recent studies have demonstrated that also astrocytes are phagocytic, and the modulation of this function could be beneficial in brain diseases. However, their molecular features as phagocytic astrocytes and their interaction with microglia in the removal of aggregated proteins have not been well characterized.
Aim and objectives: This project aims to shed light on the extent and significance of astrocytic involvement in the elimination of extracellular proteinaceous aggregates. Two primary objectives have been identified: i) unveiling the molecular fingerprint of phagocytic astrocytes and ii) exploring the functional relationship between astrocytes and microglia in aggregate clearance. The first approach involves leveraging transcriptomics to scrutinize the gene expression profile of human phagocytic astrocytes. The second aspect of the study focuses on understanding the cooperation between human astrocytes and microglia in clearing aggregated proteins using co-culture systems.
Project significance: This research will unveil previously unrecognized functions of astrocytes in protein clearance, expanding our understanding beyond the traditionally acknowledged roles of microglia. Furthermore, by elucidating the molecular features of phagocytic astrocytes, the study could reveal potential therapeutic targets for interventions in neurodegenerative disorders.

Evolutionary perspectives on acute inflammation in basal chordates.
Contact: Prof. Francesca Cima, francesca.cima@unipd.it

Due to their phylogenetic position, the defence system of tunicates has awakened, for a long time, a remarkable interest in the attempt of correlating it to the immune system of vertebrates in an evolutionary scenario. The research will be addressed to the comprehension of the content and role of polyfunctional immunocytes in a very stimulant evolutionistic context, searching for the immunocytes involved in inflammation events, potential precursors of vertebrate mast-cells, and their functional heterogeneity, immunosurveillance mechanisms, signalling and cross-talking with other circulating immunocytes. It will concern the following points by means of various techniques on research models mainly represented by ascidian species, for which the genome and transcriptome databases are publicly available, i.e., 1) morpho-functional characterisation, 2) role in immunosurveillance, 3) presence of chemical mediators and receptors with a known role in inflammation in vertebrates, 4) effects and mechanisms of action of inflammatory mediators.

Reprogramming Myeloid Cells to Overcome Immune Suppression in Colorectal Cancer.
Contact: Prof. Gaia Codolo, gaia.codolo@unipd.it

Colorectal cancer (CRC) is profoundly influenced by the tumor microenvironment, where myeloid cells play a central role in shaping immune responses. These cells, including tumor-associated macrophages and myeloid-derived suppressor cells, often acquire immunosuppressive properties that contribute to immune evasion, resistance to therapy, and disease progression. Understanding the mechanisms that regulate their function is critical for developing new immunotherapeutic strategies.
This project aims to investigate how specific signals within the tumor microenvironment influence myeloid cell behavior in CRC. The PhD student will characterize the phenotypic and functional features of tumor-infiltrating myeloid cells in patient-derived samples, using state-of-the-art technologies such as single-cell RNA sequencing, flow cytometry, and spatial imaging. Particular attention will be paid to their impact on T cell activity, cytokine secretion, and antigen presentation.
In parallel, the project will explore the therapeutic potential of targeting key pathways involved in myeloid cell-mediated immune suppression. To this end, a humanized preclinical platform will be developed, based on co-cultures of engineered macrophages and patient-derived CRC organoids. This system will provide a robust model for testing novel immunomodulatory strategies and for investigating how reprogramming the tumor-associated myeloid compartment can restore effective anti-tumor immunity.
By integrating patient-based analysis with innovative preclinical models, this project offers a unique opportunity to uncover new targets and approaches for overcoming immune resistance in colorectal cancer.

Functional characterization of miR-210 target genes in neuronal health and disease.
Contact: Prof. Cristiano De Pittà, cristiano.depitta@unipd.it

miR-210 is a highly conserved microRNA involved in various biological processes (cell differentiation, proliferation, and apoptosis) and pathological conditions, such as cancer and cardiovascular diseases. This project aims to identify, validate, and characterize miR-210 target genes in neuronal health and disease using Drosophila melanogaster and mammalian cell cultures as model systems. We will investigate expression levels in miR-210 knock-out/down and over-expressing models, validate interactions using luciferase reporter assays, and provide functional characterization of identified genes, including the previously discovered target dAcbp1 (ACBD7 human ortholog). This research will deepen our understanding of miR-210's roles in brain and eye physiology and pathophysiology using cell and molecular biology techniques, along with behavioural tests.

Collaborators: Dr. Davide Colaianni (davide.colaianni@unipd.it), Prof. Rita Maccarone (University of L'Aquila)

Environmental physiology of fish in a changing world.
Contact: Prof. Gianfranco Santovito, gianfranco.santovito@unipd.it

The research project in which the PhD student will be involved aims to study the physiological responses that fish can exhibit when exposed to anthropogenic changes, particularly concerning cellular defences against oxidative stress. Particular attention will be paid to two classes of contaminants, perfluoroalkyl substances (PFAS) and antibiotics, representing a global problem that also takes on local importance in the Veneto region. The potential impact of these pollutants on fish physiology is still largely unknown. Therefore, one of the main goals of this doctoral research is to better understand fish's physiological responses, both at the transcriptomic and proteomic levels, against the adverse effects of xenobiotic accumulation, with particular reference to cellular stress defences. By studying oxidative stress and antioxidant defences in fish species living in the river and coastal marine environments contaminated by PFAS and/or antibiotics, the project will be able to assess the resilience of the species analysed, making an essential contribution to the conservation of the environment and the maintenance of biodiversity, which are priorities of the European Commission.

Mitochondrial quality control in neurodegenerative diseases.
Contact: Prof. Elena Ziviani, elena.ziviani@unipd.it

Mitochondrial dysfunction and quality control has become a central theme in neurodegenerative diseases. Mitochondrial stress can lead to the release of reactive oxygen species (ROS), which triggers inflammation and cell death. Thus, approaches that boost mitochondrial autophagy (mitophagy) have the potential to clear damaged mitochondria as sources of ROS, and prevents neuroinflammation and neuronal cell death. Mitophagy can be triggered by post-translational modifications (PTM) such as ubiquitination. Ubiquitination of mitochondrial proteins in particular is a well-known molecular mechanism that stimulates the so-called ubiquitin mediated mitophagy pathway. The PhD candidate will explore the potential of enhancing basal mitophagy as therapeutic strategy to treat neurodegenerative diseases. Moreover, he/she will study how post-translational modification of contact sites between mitochondria and ER, which are known to influence mitophagy, impact cell physiology, in both physiological and pathological contexts. The project will be developed by using classical and high throughput based fluorescence microscopy methods, as well as subcellular fractionation procedures coupled to proteomic analysis including western Blotting and Mass spectrometry.

Curriculum Evolution, Ecology and Conservation

Funded by External Public or Private Bodies/Departments

Detecting feedback of regime shifts in marine populations under global changes: a comparison across contrasting species and different Large Marine Ecosystems.
Contacts: Prof. Camilla Sguotti, camilla.sguotti@unipd.it

This PhD project is part of FEEDRES (an ERC Starting Grant project awarded in 2024). The overall goal of FEEDRES is to model feedbacks of regime shifts in Large Marine Ecosystems (LMEs) using advanced statical modelling techniques. The PhD project will revolve around the study of regime shifts and their feedbacks in marine populations (from plankton to fish) in different ecosystems around the world. Using available data from global datasets, the PhD will model marine populations and how these change over time depending on external pressures

such as Climate Change and Fishing. The ultimate goal of the project will be to understand what are the mechanisms that induce or not the occurrence of regime shifts in marine populations and how these dynamics might propagate to higher organizational levels (i.e. community and ecosystems). The project will require an intensive use of computational approaches, in particular, the use of the software R and a range of statistical methodologies.

Annealing Molecular and Organismal Research through Reticulation, Integration, and -Omics.
Contacts: Prof.Gil Rosenthal, gil.rosenthal@unipd.it

The project connects individual reproductive decisions, before and after mating, with their consequences for micro- and macroevolutionary processes. Work is focused on naturally hybridizing swordtail fish (Poeciliidae, Xiphophorus) around the CICHAZ field station in Mexico's Sierra Madre Oriental. Major project components include using state-of-the-art tracking technology to analyze behavioral patterns before mating , measuring interactions between sperm and female reproductive isolation after mating, identifying candidate gene regions involved in reproductive isolation, and comparing realized mating outcomes to quantitative expectations for genetic compatibility. A variety of complementary -omics approaches will be used to characterize genes involved in fitness variation and assortative mating. The ideal candidate will have some combination of the following and a willingness to learn more: computational skills in Python and/or R; familiarity with bench and bioinformatic techniques in evolutionary genetics, transcriptomics, proteomics, or epigenomics; good conversational Spanish; exposure to remote and/or biodiverse locations; proficiency rearing and manipulating small freshwater fish; experience with the design and execution of behavioral experiments. Candidates must be eager to spend at least 2 months a year at CICHAZ in Calnali in the Sierra Madre Oriental and most of the rest of their time in Padova. Two new PhD students will join four postdoctoral fellows and a technician working between Italy and Mexico on this exciting system.

Network and quantitative biology: aspects of evolution, ecology and conservation

For the topic of this project please refer to any of the projects Funded by the University reported below.

Funded by the University

Understanding ecological interactions in urban river ecosystems under multiple interacting pressures
Contact: Prof. Alberto Barausse, alberto.barausse@unipd.it

River ecosystems lie at the interface of land and water and thus, especially in urban and periurban settings, are under multiple pressures (poor water quality, morphological and eco-hydraulic alterations, biological invasions, climate change, etc.) threatening the ecological connectivity, biodiversity and services they support. Numerous ecological quality indicators for watercourses exist based on physical, chemical and biological perspectives, whose quantitative relationships with human pressures is however unclear due to our incomplete knowledge of ecological interactions in riverine communities. This project aims to advance the theoretical understanding of ecological interactions in urban river ecosystems under multiple interacting pressures by combining field sampling in selected sites, statistical analysis of large datasets (e.g. collected by environmental agencies over the years within the Water Framework Directive), and controlled experiments. This information will also contribute to better management practices and a more integrated and sustainable management of European watercourses.

Genomic insights into threatened Italian Alpine endemic plants: Integrating herbariomics and functional trait analyses for conservation

Contact: Supervisor Prof. Francesco Dal Grande, francesco.dalgrande@unipd.it,
Co-supervisor: dr. Francesco Petruzzellis, francesco.petruzzellis@unipd.it

The ongoing loss of biodiversity is particularly severe in alpine ecosystems, where climate change and habitat fragmentation pose significant threats to endemic plant species. This PhD project aims to generate comprehensive genomic resources and functional trait data for key Italian Alpine endemic plants, leveraging a multidisciplinary approach combining herbariomics, genomics, and functional trait analyses.
By sequencing historical herbarium specimens and contemporary populations, this research will reconstruct the genomic diversity and evolutionary trajectories of targeted Alpine endemics over the last century. Concurrently, detailed analyses of functional traits, including physiological responses, morphological adaptations, and reproductive biology, will link genomic data to ecological resilience and adaptive potential.
Integrating herbarium-derived genomic insights with contemporary functional traits will enable robust predictions of species' vulnerability to ongoing environmental changes, facilitating evidence-based conservation strategies. This project underscores the critical role of historical collections as genomic resources, providing innovative perspectives to conserve Italy's unique Alpine biodiversity.

Climate change as driver of evolution in behaviour and reproduction

Contact: Prof. Clelia Gasparini, clelia.gasparini@unipd.it

Climate change is emerging as a strong selective pressure targeting behavioural and reproductive traits. The proposed PhD project aims to explore how extreme, yet ecologically relevant thermal events, such as heatwaves, affect the evolution of sexual behaviour, fertility, and reproductive strategies. The possible species for this study are guppy, zebrafish, or cockroach. Using an experimental approach, the general idea is to assess the impact of heatwaves on different key traits associated to fitness, including behaviour, sexual selection dynamics, and intergenerational effects. Special attention will be given to sex-specific responses and inter-individual differences, to ultimately understand whether phenotypic plasticity and evolutionary adaptation interplay and can potentially buffer the effects caused by extreme events. The findings will provide new insights into how climate acts as a driver of behavioural and reproductive evolution, with important implications for biodiversity conservation and population resilience under future climate scenarios.

Unraveling the genomic drivers of phenotypic variation in endangered species

Contact: Supervisor Prof. Alessandro Grapputo, alessandro.grapputo@unipd.it
Co-supervisor Prof. Leonardo Congiu, leonardo.congiu@unipd.it

Adaptation is only possible if genetic variation exists, and it primarily originates from mutations. However, mutations arising in locally adapted populations are likely to be deleterious. Declining and endangered populations are expected to carry a higher load of deleterious variation, namely genetic load, which likely affects their fitness and potential to recover. Understanding the causal links between genetic load and phenotypic variation is thus crucial for conservation concerns.
Leveraging cutting-edge genomic tools, this PhD project aims to disentangle the mechanisms by which phenotypic variation is shaped by genomic variability. Our goal is to foster the integration of genotypic and phenotypic data in non-model, declining species, such as the Adriatic sturgeon, for which a reference genome has recently become available. Additionally, the way in which genomic composition determines the phenotype in a polyploid organism is

complex and not yet well understood. To address this, we will analyse available transcriptomic data, with the aim of investigating gene expression patterns and compare them with genomic information at target loci.

Leveraging population structure in genome-wide association statistics and Natural Selection scans
Contact: Prof. Massimo Mezzavilla, massimo.mezzavilla@unipd.it

A comprehensive understanding of genetic differences between populations is critical to avoid confounding in genome-wide association studies (GWAS) and to better understand the evolution of human genes and traits. This concept, referred to as genetic structure or genetic stratification, is a feature found in populations at various levels. Population genetic structure is a key factor contributing to spurious associations in GWAS, construction of polygenic risk scores (PRS), and inaccuracies in other genomic approaches based on the assumption of a homogeneous cohort. With this project the candidate will have the opportunity 1) Developing a novel framework capable of detecting not just the presence of population structure but also quantifying it, providing guidelines to enhance GWAS, PRS and natural selection scans 2) Rather than correcting for population structure, the candidate will exploit it through the created framework to uncover distinct features of all possible subpopulations present in a cohort. 3) Using publicly available data from various Biobanks the candidate will perform GWAS analyses using the created framework approach.

Community dynamics in extreme environments: Insights from Mediterranean Hydrothermal Vents.
Contact: Prof. Isabella Moro, isabella.moro@unipd.it

Marine ecosystems are undergoing rapid alterations due to climate change, with ocean acidification (OA) emerging as a key driver of biodiversity shifts. Natural CO_2 vents provide unique settings to study these effects, mimicking future ocean conditions. This research aims to examine biodiversity patterns, species turnover, and the potential establishment of non-indigenous species (NIS) in Mediterranean shallow hydrothermal vents. By integrating in situ sampling, transplantation experiments, and DNA metabarcoding, the project aims to unravel how the ocean acidification reshapes community dynamics. Results will offer critical insights into ecosystem resilience and functional stability under future climate scenarios.

An integrated genetic and morphological approach to study the population structure of the whiting Merlangius merlangus
Contact: Prof. Chiara Papetti, email: chiara.papetti@unipd.it

The whiting (Merlangius merlangus, Linnaeus 1758) is a commercial species distributed in the North Atlantic Ocean and in the Mediterranean Sea. The Northern Adriatic population is an important fishery resource and differs from others in the NE Atlantic Ocean and Black Sea in many life-history traits and otolith morphology. Being a cold-water species, the whiting of the Northern Adriatic Sea has little possibility of shifting distributions to colder waters in response to well documented increases of sea surface temperature induced by human-driven climate change. Hence, the population of whiting in the Northern Adriatic Sea might be at risk of demographic collapse impacting the local fishery and the composition and functioning of associated marine communities. The proposed project aims to investigate if the life-history and otolith morphology differences between the whiting population of the Northern Adriatic Sea and other populations of this species correspond to genetic differences. This study also aims to characterize the ecological role of the whiting in relation to the different environmental conditions within the distribution area. This will be investigated through the analysis of multiple markers at genome-wide scale and the comparison of genetic results with data of otolith

morphology and diet of samples collected in different geographic areas. If the Adriatic Sea hosted a highly differentiated population or a subspecies of M. merlangus, new management strategies should be developed to avoid demographic collapse and overexploitation.

Positions without scholarship

Ecological characteristics and fishery interactions of the Blackchin Guitarfish (Glaucostegus cemiculus) in Cyprus: a study integrating different methodologies.
Contacts: Prof. Carlotta Mazzoldi and Prof. Alberto Barausse,
carlotta.mazzoldi@unipd.it ; alberto.barausse@unipd.it

The Blackchin Guitarfish, Glaucostegus cemiculus, is a critically endangered elasmobranch species distributed in the Atlantic Ocean and Mediterranean Sea. This species was historically common throughout the Mediterranean, but has now disappeared from several areas, calling for urgent conservation efforts. It is included in Appendix II of CITES and Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals, however knowledge about its ecological traits and interaction with fishing activities is still poor in this area, impairing the development of conservation actions.
This project will be developed within the Life Prometheus Project (LIFE-PROMoting Elasmobranchs conservation THrough by-catch reduction, Ecotourism and alternative sUStainable fisheries) and will aim at studying the ecological characteristics of the Blackchin Guitarfish in Cyprus in collaboration with the Marine & Environmental Research (MER) Lab with the final goal to contribute to the development of conservation actions. Specifically, the project will evaluate: 1) The distribution and the spatial use of the Blackchin Guitarfish in Cypriot waters in relation to the habitat, species life stage, season; 2) The interactions with professional and recreational fishing activities. To collect data, several methods will be used and integrated: citizen science (e.g., fishers, divers); local ecological knowledge; field observations through SCUBA diving, onboard fishing boats and during recreational fishing activities and competitions; deployment of BRUVs (Baited Remote Underwater Videos); acoustic telemetry.
Expertise in the study of the ecology of marine species, field work and interaction with stakeholders is required.

Curriculum Genetics, Genomics and Bioinformatics

Funded by External Public or Private Bodies/Departments

Crosstalk of cancer genome and tumor microenvironment in ovarian cancer metastases at a single cell resolution.
Contact: Prof. Chiara Romualdi, chiara.romualdi@unipd.it

Ovarian cancer is the leading cause of death from gynecological malignancies and is often diagnosed at an advanced metastatic stage. Metastases form a complex ecosystem of diverse, interacting cells, whose genomic and transcriptomic heterogeneity shapes the tumor microenvironment (TME) and drives tumor aggressiveness. Despite extensive research, the mechanisms underlying tumor–TME crosstalk remain unclear.This project aims to explore the interplay between cancer genomes and TME composition in primary tumors and matched metastases across different histotypes. The candidate will use computational approaches to analyze genomic and transcriptomic profiles at single-cell resolution, comparing primary and metastatic sites.

Generation of early embryonic development models based on mammalian pluripotent stem cells.
Contact: Prof. Graziano Martello, graziano.martello@unipd.it

Organ transplantation is the ultimate treatment for organ failure. However, the number of organs available for transplantation is not sufficient to meet the clinical demand. For this reason, alternatives sources of organs are urgently needed. Blastocyst complementation is a promising approach to generate humanized organs in pigs, which could be a source of transplantable organs that would resolve this worldwide sanitary issue. This method has been successfully used for the generation of organs intra and interspecies with rodent cells and models, and a few studies have reported the generation of organs intraspecies in pig. Although human induced pluripotent stem cells (iPSCs) have been used to generate
interspecies chimera in mouse and pig, the main current limitation to produce humanized organs is the low chimerism obtained.
The aim of this project is to gain knowledge on the molecular basis of the chimeric potential of hiPSCs and to develop new strategies to boost the chimerism inter-species. Specifically, we aim to decipher the molecular basis of the chimeric potential of human iPSCs and to perform high-throughput in vitro screening of the chimeric potential of hiPSCs cultured in different conditions.
To achieve this aims PSCs of different species will be cultured and used to form 3D models of early development.
Molecular biology techniques (cloning, qPCR, transcirptomic analyses) will be used routinely, together with genome engineering.
In sum, the goal of this project is the production of hiPSCs with high chimeric potential, which would be the base for the future generation of humanized organs in pig recipients and a major breakthrough in the stem cells field which have the potential to be exploited by biotech companies.

Development of gene therapy approaches for Huntington diseases in human neurons and organoids derived from pluripotent stem cells
Contact: Prof. Graziano Martello, graziano.martello@unipd.it

Huntington's disease (HD) is caused by CAG expansion in the HTT gene. The resulting mutant huntingtin protein (mHTT) alters several cellular processes, leading to the loss of striatal neurons.
The project proposes an innovative approach to treating HD, focusing on neuronal protection rather than reducing the mHTT, thereby overcoming the limitations of current strategies primarily based on RNAi and antisense oligonucleotides. The MTF1 gene and other candidates, identified as neuroprotective in Prof. Martello's laboratory, will be validated in both three-dimensional and two-dimensional human models of striatal neurons,using advanced transcriptomics, proteomics, and gene therapy technologies.
The project is focussed on developing new in vitro models of HD, like striatal organoids, that better reflect human pathophysiology compared to traditional murine models. The use of patient-derived iPSCs enables the study of early disease stages and the testing of gene therapy effectiveness using mRNA and AAV.
Validating MTF1 as a therapeutic candidate could open new avenues for treatments applicable to other neurodegenerative diseases, strengthening the project's potential clinical and industrial impact.

Evaluation of novel therapeutic approaches for arrhythmogenic cardiomyopathy.
Contact: Dr. Martina Calore, martina.calore@unipd.it

Arrhythmogenic cardiomyopathy is a genetic cardiac disorder characterized by fibro-fatty replacement of the myocardium which results in fatal arrhythmias, especially in the young. Currently, there is no e=ective treatment for the disease. In this PhD project, we aim to test

novel therapeutic approaches for ACM based on gene therapy, using preclinical models for the disease.

Network and quantitative biology: aspects of genetics, genomics and bioinformatics

For the topic of this project please refer to any of the projects Funded by the University reported below.

Funded by the University

Function of the von Hippel-Lindau (VHL) gene in blood disorders using zebrafish mutants and transgenic lines.
Contact: Prof. Francesco Argenton, francesco.argenton@unipd.it

This project aims to elucidate the function of the von Hippel-Lindau (VHL) gene in blood disorders, particularly microcytemia, using zebrafish mutants and transgenic lines. We will generate VHL mutant zebrafish using CRISPR-Cas9 technology and develop fluorescent reporter lines to visualize VHL expression in hematopoietic tissues. Phenotypic analysis will assess blood cell morphology, count, and hemoglobin content, while RNA-seq will identify dysregulated genes in VHL mutant blood cells. Rescue experiments and drug screening will be conducted to explore potential therapeutic approaches. Additionally, we propose a novel approach using zebrafish and chicken chimeras to study xenografts of human cardiomyocytes differentiated from induced pluripotent stem cells (iPSCs). Human iPSC-derived cardiomyocytes will be injected into early-stage zebrafish and chicken embryos, and their integration, functionality, and vascularization will be monitored. This comparative study will evaluate the advantages and limitations of each chimeric model for xenograft research. The project aims to provide insights into VHL-associated blood disorders and establish new platforms for studying human cell behavior in vivo, with potential applications in personalized medicine. Ethical considerations regarding human-animal chimeras will be addressed throughout the study.

Advanced human cardiac microtissue models with RRAGD mutations as screening platform to combat cardiomyopathy.
Contact: Prof. Milena Bellin, milena.bellin@unipd.it

Heterozygous mutations in the gene encoding RagD GTPase (RRAGD) cause kidney tubulopathy and cardiomyopathy and act by inhibiting the TFEB transcription factor. Here, we aim at creating an in vitro advanced three-dimensional (3D) human cardiac microtissue (cMT) model to

1. Establish the first human in vitro model of RRAGD cardiomyopathy

2. Dissect and correct the RRAGD cardiac phenotypes in 3D human “mini-hearts”

The PhD student will work with patient-specific human induced pluripotent stem cells (hiPSCs) and build 3D cMTs to assess molecular and functional phenotypes as well identify rescue approaches. As part of the maturation procedure for the cMTs, we will also use cMT-Zebrafish xenografts.

Enhancing black soldier fly immunity for waste reduction and feed sustainability.
Contact: Prof. Federica Sandrelli, federica.sandrelli@unipd.it

Europe currently relies on imports for 70% of its animal feed protein. To reduce this dependence, the European Parliament has called for alternative sources. A promising solution

is the recovery of millions of tons of organic waste generated each year to produce sustainable animal feed. Insects efficiently convert waste into protein for animal feed, reducing land pressure. Recent regulations now allow their use in aquaculture, poultry, and pig feed. Hermetia illucens, the black soldier fly (BSF), is one of the most promising insect species for organic waste reduction and sustainable feed production. This project focuses on BSF larvae, aiming to enhance their immune responses and immune effector production. It includes studying and stimulating immune regulatory pathways able to induce a massive production of immune effectors in BSF larvae, by using microbiological, biochemical, molecular biology, and transcriptomic approaches. The findings will support organic waste reduction, promoting a more sustainable and nutritionally improved animal feed.

Investigating POLG/POLG2 Disorders in Zebrafish: Mechanisms and Drug Discovery.
Contact: Prof. Natascia Tiso, e-mail natascia.tiso@unipd.it

POLG disorders are a group of mitochondrial diseases caused by mutations in nuclear-encoded genes essential for mitochondrial DNA replication and maintenance. Among them, POLG and POLG2 play key roles: POLG encodes the catalytic subunit of mitochondrial DNA polymerase gamma, while POLG2 encodes its dimeric accessory subunit.
In recent years, our team successfully established Polg and Polg2 zebrafish models, faithfully replicating disease features—particularly in cardiac and skeletal muscle—which were later exploited for drug treatment with candidate molecules.
Our next steps are to: a) develop additional Polg/Polg2 zebrafish models using CRISPR/Cas9; b) investigate their CNS activity (calcium signaling), ROS status, and mitochondrial dynamics (fission, fusion, mitophagy); c) test candidate molecules pre-screened in a yeast-based system for drug repurposing. Our ultimate goal is to fully characterize POLG disease phenotypes, mimicking human mutations within the zebrafish organism, and identify novel POLG-targeted therapies.

Development of computational approaches to dissect complex systems.
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The project focuses on the development of advanced computational methods for the integrated analysis of omics data, including genomics, epigenomics, transcriptomics, within the context of complex systems. The goal is to implement innovative tools and models that enable the management, visualization and extraction of meaningful biological insights from large-scale datasets, aiming to identify biomarkers, molecular mechanisms, and potential therapeutic targets.

Investigating the biological bases of human diseases.
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The research activity will focus on the biological bases of Mendelian and multifactorial diseases. To this aim, various approaches will be used, ranging from genetic and genomic analyses to the use of in vitro and in vivo models.

Studying microbiomes for restoration and remediation purposes.
Contact: Prof. Paola Venier paola.venier@unipd.it

Bacteria, archaea, microeukaryotes, and viruses play fundamental roles in the ecosystem and are characterized by amazing biodiversity. Under the influence of abiotic factors, the living components of microbiomes evolve as functionally interconnected ensembles, changing the environmental niche and supporting the existence of all other forms of life on the planet. The study of endangered or polluted environments by using metagenomics, viromics and metabolomics is essential to circular economy and habitat restoration actions. We are actively working on coastal salt marshes, connecting the dots between environmental chemistry and marine microbiology.