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

Potassium-channel linked cellular signaling.
Contact: Prof. Ildikò Szabò, ildiko.szabo@unipd.it

The project focuses on the elucidation of the mechanisms by which a class of ion channels can modulate activation of specific transcription factors. In particular, by generating mutated ion channels, the fellow will dissect the molecular mechanisms allowing interaction and the stimuli responsible for the regulation of such cross-talk. The Ph.D. fellow will have occasion to learn several state-of-the-art techniques and work on an exciting, novel topic.

Pharmacological modulation of bioenergetic efficiency.
Contact: Prof. Ildikò Szabò, ildiko.szabo@unipd.it

The project aims to test a number of new drugs designed and synthesized in the frame of a project focusing on mitochondrial diseases. The fellow will perform in vitro and in vivo experiments to assess bioenergetic efficiency in respiratory chain deficient mouse models following treatment with the most promising new drugs.

Metabolic regulation of algae cultivated in industrially relevant environment.
Contact: Prof. Tomas Morosinotto, tomas.morosinotto@unipd.it

The aim of this project is to develop improved algal strains with targeted modifications in selected steps of photosynthesis, to close the gap with the theoretical light-into-biomass conversion efficiency.
This approach will exploit genetic tools available at UniPD (CRISPR based approaches, mutant isolation strategies assisted by phenotypic selection, efficient over-expression of genes of interest).
Once isolated, strains will be tested for the increased productivity in laboratory conditions and in pilot photobioreactors.

Curriculum Cell Biology and Physiology

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

Mitochondrial membrane contact sites (MCS) are regions of apposition between the outer mitochondrial membrane (OMM) and other membranous organelles. MCS control essential biochemical processes such as the exchange of lipids, metabolites and second messengers; yet, their exact molecular composition and biophysical features remain largely undefined. The doctoral candidate will draw upon their expertise in microfabrication and microfluidics to assemble and purify vesicles via micro- and nanofluidic techniques, employing lipid repertoires that recapitulate those of the OMM and its partner organelle (for example, the endoplasmic reticulum). These vesicles will then be reconstituted with specific protein-tether pairs characteristic of mitochondrial membrane contact sites. Through a suite of biophysical assays, the candidate will elucidate the properties of the resulting proteoliposomes. Finally, by integrating microfluidic platforms with advanced optical microscopy and optical-tweezers measurements, the student will define how variations in membrane composition influence tether mobility, residence times and tethering forces.

Study of endothelial translation in physiological and pathological angiogenesis.
Contact: Prof. Roxana Elena Oberkersch, roxanaelena.oberkersch@unipd.it

Angiogenesis, the formation of new blood vessels from pre-existing vasculature, is fundamental to both physiological processes and pathological conditions, including tumor progression. Current anti-angiogenic therapies primarily target vascular endothelial growth factor (VEGF) signaling and have demonstrated significant potential in inhibiting tumor development. Nonetheless, their clinical effectiveness remains limited. Emerging evidence suggests that modulating key molecular pathways involved in endothelial metabolic reprogramming could represent a promising therapeutic alternative in cancer-related diseases. The dynamic regulation of these metabolic pathways often requires cells to rapidly integrate endogenous metabolic cues with external nutrient availability and endocrine stimuli. This level of precision may be more efficiently achieved through translational control mechanisms, which fine-tune global or mRNA-specific protein synthesis to adapt cellular metabolism. Despite growing interest in the interface between metabolism and translation, it remains unclear whether manipulating mRNA translation alone can fully rewire endothelial metabolic activity to impede pathological angiogenesis. Therefore, this project aims to investigate whether endothelial cells undergo translatome remodeling to enact rapid and selective proteomic changes that define a pro-angiogenic metabolic signature under physiological and tumor conditions.

Study of Translational Remodelers in Angiogenesis.
Contact: Prof. Roxana Elena Oberkersch, roxanaelena.oberkersch@unipd.it

Angiogenesis, the formation of new blood vessels, is a fundamental biological process with broad implications in both physiological and pathological contexts. While the transcriptional regulation of angiogenesis is well characterized, its translational regulation remains comparatively underexplored. This project aims to identify translational factors that function as translatome remodelers in response to angiogenic stimuli and to evaluate whether their inhibition affects endothelial cell (EC) metabolism and vessel formation. To investigate these mechanisms, integrated analyses—including metabolome profiling, nascent proteome mapping, and MATRIX experiments—will be employed to elucidate how translational modulation shapes metabolic cues during physiopathological angiogenesis. In addition,

bioinformatics-driven approaches will be utilized to integrate multi-omics datasets and identify regulatory networks linking translational reprogramming to metabolic adaptation.

Curriculum Evolution, Ecology and Conservation

Development and testing of new eco-engineering concepts for multifunctional and sustainable coastal defense structures.
Contacts: Prof. Laura Airoldi, laura.airoldi@unipd.it

This PhD project will explore innovative ecological strategies for coastal protection, withing the international project BLUESHORES. The research will investigate how biodegradable and biogenic eco-engineering elements—such as BESE structures and oyster reefs—can be used to re-establish native saltmarsh vegetation and oyster habitats while simultaneously mitigating coastal erosion. Emphasis will be placed on understanding the biogeomorphological synergies between different components, assessing how their interactions facilitate habitat formation and ecosystem functioning under varying hydrodynamic and tidal conditions.

Through controlled field trials at diverse European sites, the project will evaluate ecological indicators including biodiversity recovery, habitat complexity, and ecosystem service provision. The ultimate aim is to contribute to the development of scalable, nature-based coastal defense solutions that balance engineering performance with ecological integrity and long-term sustainability.

The student will gain expertise in coastal ecology, eco-engineering, and habitat restoration. They will learn to design and assess nature-based solutions through fieldwork, ecological monitoring, and data analysis. Collaboration within an international, interdisciplinary team will also develop their project management and stakeholder engagement skills. Due to the nature of the activities involved, holding a scientific diving certification valid in Italy is a preferred qualification.

Detecting feedback of regime shifts in marine populations and communities.
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) and communities in different ecosystems around the world. Using available data from global datasets, the PhD will model how different systems change over time due to 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 such as communities. The project will require an intensive use of computational approaches, in particular, the use of the software R and a range of statistical methodologies.

Curriculum Genetics, Genomics and Bioinformatics

Decoding anaerobic microbiomes at single-cell resolution: integrative genomic and transcriptomic approaches.

Contact: Prof. Stefano Campanaro, stefano.campanaro@unipd.it

Single-cell sequencing is transforming our understanding of microbial ecosystems by enabling genome- and transcriptome-level profiling of individual cells. While well-established in eukaryotic systems, its application to prokaryotic communities, especially anaerobic microbiomes, remains technically challenging due to low nucleic acid yield, complex cell wall structures, and sparse data. Additionally, the bioinformatic tools previously developed for bulk DNA and RNA analysis must be adapted to the specific needs of single-cell data analysis. Nonetheless, single-cell approaches hold enormous potential to uncover hidden functional and taxonomic diversity. This project aims to develop and apply single-cell genomic and transcriptomic methods to investigate microbial heterogeneity within anaerobic environments involved in the degradation of organic matter. A key focus will be the reconstruction of individual microbial genomes to achieve strain-level resolution and to identify phages associated with specific bacterial or archaeal hosts. Understanding virus-host interactions at this scale will provide new insights into community dynamics, horizontal gene transfer, and microbial evolution. The target is to integrate high-throughput single-cell techniques, particularly droplet-based microfluidics, with tailored bioinformatics pipelines for genome assembly, binning, taxonomic classification, and phage-host linkage analysis. In parallel, transcriptomic data will be used to explore functional specialization within microbial populations.

By generating robust analytical tools and uncovering fine-scale interactions in anaerobic microbiomes, this work will contribute to the broader development of single-cell microbiology.