Live-cell imaging and genetic approaches for deciphering the metabolic role of photosynthesis regulation in the moss *Physcomitrium patens*.
Contact: Dr Alessandro Alboresi, e-mail: alessandro.alboresi@unipd.it

Plants perform photosynthesis, which exploits light energy to generate the organic substrates that sustain life on Earth. Core photosynthetic reactions take place in chloroplasts but are finely coordinated to the network of metabolic pathways of the cell and its organelles. Environmental stress disturbs the physiological status of cells and impacts photosynthetic efficiency. The aim of this PhD project is to investigate how plants respond to their surrounding environment, assessing the impact of genetic modification of molecular mechanisms that regulates photosynthetic reactions in the moss *Physcomitrium patens*. This genetic approach will be coupled to *in vivo* confocal imaging of genetically encoded biosensors to assess the impact of photosynthesis regulation on plants metabolism.

Organelle contact sites remodeling in physiology and pathology.
Contact: Prof. Marisa Brini, e-mail: marisa.brini@unipd.it

Many physiological processes are regulated by the functional and physical interaction between cellular organelles. Among them metabolism regulation has attracted major interest due to the fact that its dysfunction is associated to many human diseases. The exchange of molecules and ions between the organelles is not only essential to furnish material for metabolic reactions but also represents an important signaling pathway to coordinate different cellular processes. Recent evidence has identified organelles proximity as a critical hub for the transfer of information. Active and bidirectional exchange of molecules, lipids and ions through contact sites between endoplasmic reticulum (ER) and mitochondria, ER and plasma membrane, ER and lysosomes and possibly also mitochondria and lysosomes are crucial to maintain cell homeostasis. Intriguingly, the length, the distance and the number of contact sites could impact on this exchange and on cell wellness in terms of survival, metabolism, sensitivity to cell death or proliferation.
However, whether a mutual crosstalk in contact sites remodeling under different conditions could occur through the reorganization of their physical interaction is currently unexplored. Our research is focused on the understanding of whether and how these changes occur in physiological and pathological conditions (i.e., neurodegeneration and cancer) by applying biochemical, molecular and cellular biology approaches. Live cell imaging and confocal microscopy using contact sites sensors based on splitGFP and bimolecular fluorescence complementation (BiFC) will be also employed.

Validation and Feeding of Peptide Therapeutic Development by means of Structural Studies.
Contact: Dr Laura Cendron, e-mail: laura.cendron@unipd.it

Nowadays, over 60 peptides have been approved and administrated in clinics, while the achievement of smaller size and optimal balance of conformational rigidity and flexibility have produced novel promising candidates for targeting challenging binding sites with satisfactory binding affinity and specificity. Deciphering peptide–protein recognition determinants at the molecular level offers key information for the invention of peptide-based strategies, either aimed to interfere with endogenous proteins interactions or modify chemotherapeutics delivery. This project involves the usage of combined structural techniques to determine the molecular structure of peptide–protein complexes, as well as to contribute to computation-aided rational design and optimization of such protein binders. It will take advantage from ongoing collaborations with expert in the field on advanced high throughput methods to screen highly diverse peptides libraries targeting human substrates.
The student will benefit from a diverse and multidisciplinary environment. He/She will learn the fundamentals of recombinant protein production, protein and peptide screening and engineering, as well as biochemical and spectroscopy assays, with a particular focus on structural studies by cutting-edge techniques.

Microalgae as sustainable source of food on earth and beyond.
Contact: Prof. Nicoletta La Rocca, e-mail: nicoletta.larocca@unipd.it

Microalgae are unicellular photosynthetic organisms that use sunlight and atmospheric CO_2 for growth and their cultivation at a large scale could thus contribute to the mitigation of anthropogenic greenhouse gas

emissions. As additional advantage for environmental sustainability, microalgae cultivation does not require fertile land and thus does not compete with plants crops.
Microalgae biomass is a suitable feedstock to produce many commodities, from biofuels and chemicals to feed and is thus raising an increasing interest for several industrial applications. Microalgae biomass has long been used also as food in some Eastern Asia and African communities and it indeed has a very high nutritional value, thanks to its content of a wide spectrum of macro- and micro-nutrients, vitamins, antioxidants, bio-active fatty-acids and polysaccharides with proven beneficial effects on human health. Some microalgae species are also rich in proteins with a valuable aminoacidic composition which makes them highly interesting to replace animal proteins in our diets. Their increased consumption would drive a major reduction of both the environmental and health negative consequences of western diets, strongly leaning on animal proteins.
Finally, thanks to their ability to recycle resources, decarbonize and oxygenate atmospheres, while producing edible biomass, microalgae are also considered key players in obtaining sustainable bioregenerative life support for future human space explorations.

Role of endothelium in doxorubicin-induced cardiotoxicity.
Contact: Prof. Luigi Leanza, e-mail: luigi.leanza@unipd.it

Doxorubicin has been mainstay in cancer chemotherapy, with notable success in the treatment of solid malignancies and leukemias. The anti-cancer effectiveness of doxorubicin is accompanied by severe cardiotoxicity with mitochondrial damage playing a major role. Whereas ealier works focus on direct impact of doxorubicin on cardiomyocytes, recent studies highlight endothelium as a new target of the drug that can trigger the development and the progression of cardiomyopathy.
Our preliminary data show that transient exposure to doxorubicin induces senescence in endothelial cells leading to the development of pro-inflammatory phenotype strongly dependent on the release of mitochondrial DNA molecules. Inflammatory response has been demonstrated to be closely related to doxorubicin-induced cardiotoxicity but the involvement of senescent endothelium as a source of chronic inflammation remain unexplored. Therefore, this research project seek to investigate how doxorubicin-induced senescent endothelium impacts on the onset of cardiomyopathy. We will use cellular models to study the role of mtDNA as key signaling molecule that drives doxorubicin-induced senescence of endothelial cells and ultimately affects the function of cardiomyocytes. We will evaluate the relevance of doxorubicin-induced senescent endothelium also in vivo using an established doxorubicin-induced cardiomyopathy model in zebrafish.

Use of peptide hormones for controlling growth and development in horticultural plants.
Contact: Prof. Livio Trainotti, e-mail: livio.trainotti@unipd.it

Peptide hormones (PHs) are signalling molecules involved in short and long distance cell-to-cell communication to integrate endogenous developmental processes with environmental conditions and in mediating responses to pathogens. The project aims to shed light on the role that endogenous plant PHs have on controlling specific aspects of the plant life cycle, focusing mainly on reproduction of species producing fleshy fruit. Functional data on the role of PHs and their receptors in model and horticultural plants, as Arabidopsis and tomato, will be produced and analysed. Effects on development, growth, ripening and shelf life on fleshy fruits will be evaluated after topical application PHs. Plant-cell based systems for the biotechnological production of PHs will also be investigated.