Study of the signal pathways regulating the root development at the single-cell level under salt stress.
Contact: Dr Elide Formentin, e-mail: elide.formentin@unipd.it

In plants, roots play a central role in the absorption of water, dissolved ions and nutrients. It represents also the first organ that meets soil born biotic and abiotic stress. Root system and its architecture is largely under genetic control but can be significantly influenced by environmental factors. Root plasticity is a fundamental trait as shown for example in tolerant rice plants during acclimation to high salinity soil (Formentin et al., 2018). Root plasticity requires a developmental reprogramming in which plausibly second messengers, such as Ca^{2+} and ROS, are involved. We recently demonstrated that in rice seedlings, exposed to salt stress, calcium and ROS signals are triggered that are tightly co-ordinated and functional to salt tolerance. In roots, different cell layers owning different functions, have been identified. In Arabidopsis, it is known that ROS and Ca^{2+} waves move from the root to the shoot when the root tip is exposed to salt. However, how each cell/tissue responds to different stimuli and how crosstalk is established between ROS and Ca^{2+} at the single cell level remains still unknown. Taking advantage of innovative and integrative approaches to investigate signalling pathways in single cell type within the root (Kajala, …, Formentin et al., 2021), this project will likely unravel a currently unknown, yet central aspect of plant root plasticity. Genetically encoded probes under cell-specific promoters will be indeed used for the “in vivo” imaging of Ca^{2+} and ROS signals within and between root cell layers. The Ph.D. student involved in this project will work in a dynamic group and will have the possibility to collaborate with internationally recognized experts in the field (Profs. Costa (Milan), Bailey-Serres (USA)).

Exploring oxygenic photosynthesis under far-red/near-infrared light enriched spectra.
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The recently discovered ability of some cyanobacteria living in caves, beach rocks, hot spring mats and subtropical forests, as well as of some symbiotic microalgae, to strive under very low visible light and highly enriched in the far-red/near-infrared (FR/NIR) portion of the solar spectrum, poses intriguing questions concerning the minimal energy requirement for the efficient operation of oxygenic photosynthesis. The main objectives of the project are to explore the natural variability of the FR/NIR response in selected cyanobacteria and microalgae and to characterise them both under physiological and bioenergetics perspectives. The planned activities aim at determining the efficiency of utilising FR/NIR enriched radiation in these organisms, to estimate the trade-off limits between the extension of the light harvesting bandwidth to the NIR under shading conditions and the maintenance of highly efficient photochemical conversion. A better understanding of the mechanisms underlying it will have important repercussion for biotechnological applications. Increasing the absorption of FR/NIR light is perceived as a promising strategy to enhance photosynthetic productivity, contributing to the release of light harvesting limitations imposed by self-shading occurring both in dense agricultural canopies and in photo-bioreactors for microalgae cultivation.

Regulation of intracellular signaling pathways by tuning of diet in cancer cells.
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Mitochondria are central organelles in cell physiology. Their role in several intracellular processes related either to cell life or cell death has been clearly delineated. In this scenario, we have recently discovered that fine pharmacological tuning of mitochondrial fitness caused the downregulation of Wnt signaling. We have proved that ER-stress is involved as a key step in the molecular pathway. This research project builds up from this background and will be focused on correlate the new mitochondria-Wnt axis with diet in cancer cells, in particular melanoma and breast cancer. We will use *in vitro* and *in vivo* preclinical mouse and zebrafish models to try to discover new possible ways to modulate Wnt signaling and to avoid tumor development, progression and migration.

Exploring ion channel plasticity during cancer development.
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Many ion channels are linked to several hallmarks of cancer and crucially contribute to signaling pathways ensuring high rate of proliferation, apoptosis resistance and metastatic potential of cancer cells. In addition, some of the ion channels set the function of immune cells in the tumor microenvironment. The aim of the project is that of elucidating the signaling pathways linked to the function of two ion channels in cancer cells as well as in immune cells and to reveal the mechanisms allowing ion channel plasticity during tumor development. This goal will be achieved using cutting-edge techniques comprising also in vivo experiments in the poor-prognosis pancreatic adenocarcinoma. Ultimately, information arising from the project will allow the optimization of ion channel-based treatment of this pathology.