Plants, in contrast to many other organisms, cannot run away but need to master the full impact of environmental stresses where they are rooted. Hence, they have excellently learned to cope with abiotic stresses. Still, plant recruitment, survival, productivity and geographic distribution can be significantly filtered by environmental stressors. Besides water availability the occurrence, frequency and severity of frost events is the major factor in this respect. However, there remain substantial gaps in our understanding about low temperature injury and frost survival of plant cells, particularly about the subcellular changes that occur during freezing of plant cells.

One of the apparent changes during freezing is the transformation of liquid water to ice. While **ice susceptible plant cells** get immediately killed upon ice formation, **ice tolerant plant cells** readily survive exposure to extracellular ice masses in their tissue. Extracellular ice withdraws cellular water which is a temperature dependent process. Freeze dehydration is, additionally, influenced by cell wall rigidity, a factor which is less well understood. Upon extracellular ice formation ice tolerant plant cells either tolerate **freeze dehydration** that in extreme causes non-lethal **freezing cythorrhysis** (cells collapse and loose reversibly approximately 80% of cellular water) or survive by **supercooling.** In supercooled cells water remains liquid inside the cells but below a certain temperature threshold cells freeze intracellularly. The necessary subcellular changes allowing a cell to freeze dehydrate or supercool are not known.

By employment of improved high-resolution biophysical and cell biological techniques subcellular changes involved in the extent, velocity and dynamic of freeze dehydration and in supercooling but also in frost damage shall be studied in 14 plant species possessing diverse cell wall properties. Chemical components and structural features of cell walls will be investigated as attributes of additionally measured elastic properties to relate them to the peculiar species-specific cryo-behaviour. Results will have implications for applications related to cryo- and lyo-preservation and may provide new strategies to bioengineer increased freezing tolerance in commercially important plants. In an eco-physiological perspective the cryo-behaviour of cells shall be related to the frost demand (frequency and severity) at natural growing sites.

Results on cryo-behaviour of plant cells are particularly timely as climate change will sensitively affect frost survival of plants. At first sight this may sound counter intuitive. However, warmer winters affect plant phenology exposing them unprepared to erratic weather patterns. Devastating spring frost damages in the US (2007) may be a foretaste. Results on cryo-behaviour of plant cells will yield a solid basis for the understanding of structural, cytological and physiological mechanisms allowing plant cells to escape frost damage and eventually to survive freezing temperatures in a future climate.