

Freezing tolerance

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Freezing tolerance describes the ability of plants to withstand subzero temperatures through the formation of ice crystals in the xylem and intercellular space, or apoplast, of their cells. Freezing tolerance is enhanced as a gradual adaptation to low temperature through a process known as cold acclimation, which initiates the transition to prepare for subzero temperatures through alterations in rate of metabolism, hormone levels and sugars.^[1] Freezing tolerance is rapidly enhanced during the first days of the cold acclimation process when temperature drops. Depending on the plant species, maximum freezing tolerance can be reached after only two weeks of exposure to low temperatures.^[2] The ability to control intercellular ice formation during freezing is critical to the survival of freeze-tolerant plants.^[3] If intracellular ice forms, it could be lethal to the plant when adhesion between cellular membranes and walls occur. The process of freezing tolerance through cold acclimation is a two-stage mechanism:^[4]

- The first stage occurs at relatively high subzero temperatures as the water present in plant tissues freezes outside the cell.
- The second stage occurs at lower temperatures as intercellular ice continues to form.

Within the apoplast, antifreeze proteins localize the growth of ice crystals by ice nucleators in order to prevent physical damage to tissues and to promote supercooling within freezing-sensitive tissues and cells. Osmotic stress, including dehydration, high salinity, as well as treatment with abscisic acid, can also enhance freezing tolerance.

Freezing tolerance can be assessed by performing a simple plant survival assay or with the more time consuming but quantitative electrolyte leakage assay.^[5]

References

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