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What Happens to Trees in Winter

Purdue forester Lindsey Purcell just came out with some excellent information about what trees do in the winter: So, what do trees do in the winter? Do they freeze up like unprotected water pipes? Or burst when it gets below freezing? Yes, the below-ground parts of a tree are kept insulated by mulch, soil and a layer of snow, and that is important to survival, but the exposed parts of a tree are not protected.

Deciduous trees like maples and oaks, have a lot of water inside their trunks and branches. Water is the single most important substance for tree life, comprising nearly 80% of tree material. Although there is a little less inside the tree during the winter, if the temperature drops low enough, the water in even the most cold-hardy tree will freeze. Broadleaf, deciduous trees lose their leaves in the winter to reduce water loss inside the trunk and branches. Most needle-leaved trees, known as conifers, which include pines and spruce retain needles year-round. Needles are better at retaining water than broadleaves due to their small surface area and waxy outer coating limiting water loss to transpiration, the evaporation of water from leaves. A hard freeze or poorly timed drop in temperatures can be devastating to living tree cells since ice crystals can shred cell membranes, leading to dead leaves, branches, and even whole trees. Most trees live through the winter despite prolonged exposure to brutally cold air and wind and snow, with special strategies and planning.

When the tree enters the winter rest stage, research suggests three basic ways in which a tree prevents freezing. One is to change their membranes, so the membranes become more pliable; this allows water to migrate out of the cells and into the spaces between the cells. The relocated water exerts pressure against the cell walls, but this pressure is offset as cells shrink and occupy less space.

The second way a tree helps prevent freezing is to thicken the fluids within the cells. When days begin to get shorter, trees convert starch to sugars, which act as a natural antifreeze for the plant. The cellular fluid within the living cells becomes concentrated with natural sugars, which lowers the freezing point inside the cells, while the water between the cells is allowed to freeze. Because the cell membranes are more pliable in winter, they're squeezed but not punctured by the expanding ice crystals.

The third mechanism involves what has been described as a "glass phase," where the liquid cell contents become so viscous that they appear to be solid, a kind of "molecular suspended animation" and mimic the way silica remains liquid as it is supercooled into glass. This mechanism is triggered by the first two mechanisms and allows the supercooled contents of the tree's cells to avoid crystallizing.

This seemingly mystical combination of pliable membranes, natural antifreeze, and glasslike supercooling, with frost on the outside and viscous dehydration on the inside, helps trees avoid freezing injury to living cells. Trees are the largest, oldest living organism on our planet and don't grow older and larger without having very specific strategies for survival.

However, sometimes, trees aren't able to withstand extreme conditions, especially if nature provides an unusual change. While trees have evolved amazing strategies for withstanding the winter cold, sometimes it gets so cold that trees can explode. During spells of extreme cold or especially when trees haven't had time to acclimate before the cold arrives, the life-sustaining sap inside a tree can begin to freeze. Sap contains water so it expands when frozen, putting pressure on the bark, which can break and create an explosion, so to speak.

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