A Novel Sucrose Synthase Pathway for Sucrose Degradation in Cultured Sycamore Cells—Commentary

Huber SC, Akazawa T (1986) A novel sucrose synthase pathway for sucrose degradation in cultured sycamore cells. Plant Physiol **81:** 1008–1013

In 1986, Huber and Akazawa opened a wholly new understanding of pyrophosphate cycling as a plant adaptation for sugar use under widely different metabolic conditions. This pyrophosphate cycling, when linked to sugar metabolism, facilitates previously unrecognized adaptations in plant glycolysis. Among these are distinctive, highly efficient energetics, locally minimal use of ATP, and a capacity for interface with diverse pyrophosphate-handling reactions.

This work has broad implications for essentially all Suc-importing cells and is relevant to the balance between invertase- and Suc-synthase paths of Suc cleavage. The pyrophosphate-cycling mechanism proposed by Huber and Akazawa has special prominence for the now well-known association between Suc synthase and biosynthetic reactions for starch and cell wall formation.

This paper also provides a noteworthy example of classical metabolic modeling. An effective and innovative "working hypothesis" is derived from combined analysis of metabolite levels, compartmental volumes, extraction efficiencies, interacting pathways, and enzyme kinetics. Although the work was initially offered as a speculative framework for future studies, it was supported with evidence for all known metabolic players and features.

Since then, a series of increasingly exciting studies have arisen from the Huber and Akazawa hypothesis for pyrophosphate cycling in plant glycolysis and Suc metabolism. Among these were data indicating that this process could be linked to vacuolar storage functions (Rea and Poole, 1993) and especially active during anaerobic glycolysis (Mertens, 1991; Guglielminetti et al., 1995). In addition, more recent work has shown predicted changes in metabolism with bypasses of Suc synthase in growing potato (Bologa et al., 2003) and a role in carbon partitioning to cellulose synthesis (Hendrix, 1990; Haigler et al., 2001). The extent of Suc accumulation in sugarcane has also been enhanced by down-regulating the capacity for pyrophosphate cycling (via pyrophosphate-dependent phosphofructokinase; van der Merwe et al., 2010).

The Huber and Akazawa work is thus truly classic and continues to inspire new contributions.

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