This Week's Citation Classic™

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Pate J S & Gunning B E S. Transfer cells.
Annu. Rev. Plant Physiol. **23**:173-96, 1972.
[Department of Botany, Queen's University, Belfast, Northern Ireland]

This publication reviews information on the structure, anatomical locations, and modes of functioning of transfer cells, a highly specialized adaptation in which ingrowths of wall material increase the area of plasma membrane and thereby maximize a plant cell's potential for transmembrane flux of solutes. [The *SCI*® indicates that this paper has been cited in over 180 publications since 1972.]

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"The facts of our fortuitous discovery of transfer cells and eventual realization of their ubiquity within the plant kingdom have already been given by my colleague Brian Gunning in a recent *Citation Classic* concerning our first major publication[1,2] on the topic. The article reported on here, also relating primarily to our joint work in Belfast, Northern Ireland, was solicited by *Annual Review of Plant Physiology* as an opportunity to comment primarily on the functional significance, if any, of the cell type. After much soul searching, due mainly to lack of concrete information on the physiology of all but a few of the several classes of transfer cells, we accepted the invitation. At least, we argued, it would enable us to combat the opinions of our sternest critics, who regarded the spectacular wall ingrowths of the cells merely as vestigial appendages, possibly even responses to infection by microorganisms, and more likely to be 'cul-de-sacs' than 'highways' in the plant solute circulatory system!

"The hypothesis of the review was a bold one, namely, that the wall-membrane apparatus of the transfer cell represented a versatile structural:functional module, facilitating intense solute fluxes in a wide variety of anatomical or physiological situations. In some instances, it was associated with solute exchange (absorption or secretion) with the environment external to the plant. In others, it was associated with solute transfers between the living (symplast) and the dead (apoplast) internal compartments of the plant, particularly in relation to the loading or unloading of long-distance transport channels of xylem and phloem. In yet others, it was associated with the exchange of solutes across cytoplasmic discontinuities between mother and daughter nuclear generations of the plant.

"When the review was written, only three situations for the cell—the root nodule of legumes, the vasculature of the minor leaf veins of higher plants, and the gametophyte: sporophyte junction of mosses and ferns—seemed to offer conclusive proof of transfer cells functioning unequivocally in solute exchange, even if only because the one pathway for the solutes in question simply had to be across transfer cell membranes! Further study relating quantitative assessments of solute fluxes across regions of the plant where transfer cells abound has consistently supported the concept of their being strategically located at specific 'bottlenecks' in the circulatory system.[3,4] But the question still remains of whether the cell type does indeed function more effectively than equivalently sized and placed cells not equipped with wall ingrowths.

"The high citation rate which the paper has enjoyed no doubt relates to its use in the large number of structural and functional studies on plant transport phenomena in which the cells have been encountered or suggested to play a vital part. Perhaps the best compliment we can possibly receive is to see the term 'transfer cell' accepted into general botanical parlance—with the necessity for reference to the authors who were so lucky to stumble on the cell type and have the chance to guess as to its significance!"

1. **Gunning B E S & Pate J S.** "Transfer cells": plant cells with wall ingrowths, specialized in relation to short distance transport of solutes—their occurrence, structure, and development. *Protoplasma* **68**:107-33, 1969.
2. **Gunning B E S.** Citation Classic. Commentary on *Protoplasma* **68**:107-33, 1969. *Current Contents/Agriculture, Biology & Environmental Sciences* **14**(43):18, 24 October 1983.
3. **Pate J S & Layzell D B.** Carbon and nitrogen partitioning in the whole plant—a thesis based on empirical modelling. (Bewley J D, ed.) *Nitrogen and carbon metabolism*. The Hague: Martinus Nijhoff/W. Junk, 1981. p. 94-134.
4. **Pate J S.** Distribution of metabolites. (Bidwell R G S & Steward F C, eds.) *Plant physiology: a treatise. Volume VIII: nitrogen metabolism*. New York: Academic Press, 1983. p. 335-401.