

This Week's Citation Classic

Ledbetter M C & Porter K R. A "microtubule" in plant cell fine structure. *J. Cell Biol.* 19:239-50, 1963. [Biological Laboratories, Harvard University, Cambridge, MA]

'Microtubules' are reported as cytoplasmic constituents of higher plants. They are about 240 Å in diameter, of indeterminate length, and morphologically identical to tubules of mitotic spindles. During interphase they lie near the plasma membrane and mirror in orientation the cellulose microfibrils of adjacent cell walls. [The *SCI*[®] indicates that this paper has been cited over 480 times since 1963.]

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"Work reported in this paper was done while I was associated with my collaborator in his laboratory at Harvard University, and was the culmination of a study begun in 1961 at Rockefeller University. We were searching the cortical cytoplasm of plant cells for some organization in fine structure to account for the patterns of wall deposition so important in cell differentiation. Preparation of our cells for electron microscopy had progressed from the limited permanganate fixation in vogue to phosphate buffered osmium tetroxide; however, even this more faithful preservation was disappointing in showing a discontinuity in the cytoplasm in the zone of particular interest—the cortical layer of the cytoplasm.

"Shortly after the introduction of dialdehyde fixation by Sabatini *et al.*,¹ Keith Porter called my attention to some slender elements which appeared

in various animal cells fixed in this new way, and he suggested I be on the look-out for them in plant cells. With his usual perspicacity, Porter suspected new, universal element of cell fine structure was in the offing. Our first views of these elements in plant cell sparked excitement because of their placement, predominantly in the very cortical zone which up to then had been so puzzlingly empty. The newly found microtubules were in an appropriate place to influence wall deposition and, moreover, they mirrored in orientation the adjacent microfibrils of cellulose being deposited in the walls. Once we tied the arrangement of these structures in the cytoplasm to a probable function, writing began.

"Chief among the reasons this paper has been so frequently cited is that it helped establish microtubules as important, universal components of eukaryotic cytoplasm. It is significant, in this respect, that microtubules were reported here in plant cells (Slautterback reported them in *Hydra* that year),² where their location and parallelism to wall components were fortuitous. The characteristics of these cytoplasmic tubules made it possible to point out their probable relationship to structures of known or suspected function, such as mitotic spindle fibers and filaments of cilia and flagella. And finally, it was a subject whose time had come, as evidenced by the flood of related papers which followed, and eventually the summaries³ and symposia. As to timeliness, it is noteworthy that just as our paper was submitted for publication we learned through Eldon Newcomb of work Peter Hepler and he were doing with *Coleus* stems⁴ in which microtubules were found. We were fortunate in having looked in the right place with the right techniques at the right time."

1. Sabatini D D, Bensch K G & Barnett R J. The preservation of ultrastructure and enzymatic activity by aldehyde fixation. *J. Cell Biol.* 17:19-58, 1963.
2. Slautterback D B. Cytoplasmic microtubules. I. *Hydra*. *J. Cell Biol.* 18:367-88, 1963.
3. Dustin P. *Microtubules*. New York: Springer-Verlag, 1978. 452 p.
4. Hepler P K & Newcomb E H. Microtubules and fibrils in the cytoplasm of *Coleus* cells undergoing secondary wall deposition. *J. Cell Biol.* 20:429-533, 1964.