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This Week's Citation Classic®

Cardell R R, Badenhausen S & Porter K R. Intestinal triglyceride absorption in the rat: an electron microscopical study. *J. Cell Biol.* 34:123-55, 1967.
[Biological Laboratories, Harvard University, Cambridge, MA]

Experiments reported in this paper provided morphological evidence that fat transport through the intestinal absorptive cell occurs by diffusion of free fatty acids and monoglycerides across the plasma membrane. Resynthesis of triglyceride occurs in the smooth endoplasmic reticulum. This uptake and use of monoglycerides and fatty acids presumably maintains a concentration gradient that favors fat diffusion across the apical membrane. The fat droplets move, in part, to the Golgi apparatus and eventually are secreted as chylomicrons into the intercellular space via exocytosis through the lateral cell membranes. [The *SCI*® indicates that this paper has been cited in over 245 publications.]

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In the summer of 1964 I joined the large and exciting group of cell biologists working with Keith R. Porter at the Biological Laboratories of Harvard University. I had been invited to be a research associate with Keith and Carlo Bruni, specifically to collaborate on studies of the smooth endoplasmic reticulum (SER) in liver cells. I had just spent four years in the Biophysics Department at the Ford Institute for Medical Research in Detroit, Michigan, where my research time was not interrupted by teaching courses and training students. Soon after my arrival at Harvard, Keith mentioned that he would like help with an advanced graduate course in cell biology that he intended to organize around various aspects of intestinal transport. He assigned several students to a group led by Susan Badenhausen and me, and our goal was to design and carry out experiments related to the intestinal absorption of fat.

I recall wondering why I agreed to be involved in this project since it infringed upon my time for studying SER in the liver cell. Furthermore, I knew almost nothing about the intestinal absorptive cell and had no interest in fat metabolism. But Keith has a way of transmitting his enthusiasm for a project to others and very soon I and everyone in the group were reading the literature, giving journal reports, and performing experiments.

It was evident from some of the classical papers[1,2] in the literature and our preliminary experiments that the transport of fat across the intestinal absorptive cell was a very important and interesting cell phenomenon. The study was facilitated by the structural organization of this cell and because it was possible to visualize the triglyceride droplets in the various cellular organelles with both the light and electron microscopes. Thus, the route of the triglyceride molecules through the cell under various experimental conditions could be followed morphologically. We developed some appropriate fat-soluble markers that proved useful in the interpretation of the results.

I believe that this paper became a *Citation Classic* because it related the available biochemical information on fat absorption to the morphology of the cell. My participation in this study taught me the value of integrating information from various approaches in order to understand more fully a cellular process.

Obviously, I am very gratified that this paper has been highly cited by other investigators. But I am also proud that the interpretation, diagrams, and electron micrographs from this paper have found their way into most of the histology textbooks.[3] I hope that the presentation of the data is useful to students learning the functions of the intestinal absorptive cell. More important, perhaps, I hope that this work inspires students to pursue cell-biology studies, since it really was students in a graduate course who stimulated us to design and conduct these experiments. I urge teachers to continue organizing courses that stimulate both the teacher and the student to ask and attempt to answer important scientific questions by laboratory experiments.

Finally, I would like to comment that from my association with Keith, an outstanding scientist and exceptional teacher, I realized that teaching and research are often inseparable. Each complements the other. For that reason I believe it is a mistake for granting agencies and administrators to be overly concerned about "percentage effort" on a research project by an investigator who has significant teaching commitments. The teaching efforts of a scientific investigator frequently lead to important experiments and the publication of research articles. Occasionally one of these articles may become a *Citation Classic*.

1. **Palay S L & Karlin L J.** An electron microscopic study of the intestinal villus. I. The fasting animal. *J. Biophys. Biochem. Cytol.* 5:363-71, 1959. (Cited 370 times.)
2. ————. An electron microscopic study of the intestinal villus. II. The pathway of fat absorption. *J. Biophys. Biochem. Cytol.* 5:373-83, 1959. (Cited 410 times.)
3. **Fawcett D W,** ed. *Bloom and Fawcett. A textbook of histology.* Philadelphia, PA: Saunders, 1986. 986 p.

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