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Membrane Transport Involved in the Accumulation of Bio-Active Compounds in Plants —Analogy an Difference to Animal Cells—

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Plants produce more than 200,000 compounds, which far exceeds the number of metabolites in animals. The main reason for the chemical divergence in plants is the development of “secondary metabolism” in plants, and those metabolites are divided into several groups according to their chemical structures, e.g. alkaloids, isoprenoids, and polyphenols. Some of them show beneficial effects for human health and also used in clinical field to treat patients utilizing their divergent biological activities. On the other hand, those active compounds are potentially toxic to plant cells themselves, and thus plants should have abilities to cope the toxicity from their own metabolites.

One of major differences of plant cells from animal cells is the existence of vacuoles. Vacuole is the largest organelle that may occupy more than 80% of cell volume in plants, and it is proposed that vacuoles play a major role in sequestrating biologically active compounds in the matrix. Indeed, cultured plant cells that are capable of producing alkaloids often accumulate these toxic compounds exclusively in the vacuoles [1)]. Plants can also conduct a long distance transport of secondary metabolites from source cells to sink organs. Recently we have identified a transporter molecule responsible for the translocation of nicotine from roots to leaves in tobacco plants [2)].

In plant genomes a higher number of transporter genes than animal genomes are observed, e.g. more than 120 ATP-binding cassette (ABC) transporters and more than 50 MATE (multidrug and toxic compound extrusion) members are identified in Arabidopsis, which will be relevant for the sessile life style of plants [3)]. Interestingly, some of those plant transporters show strict substrate specificity to endogenous organic substances, which are closely related to the life maintenance and are important for the development of the plant body, whereas many ABC and MATE transporters in mammals are recognized as multiple drug efflux transporters. The difference in the biochemical properties and physiological roles of plant transporters will be discussed in comparison to animal transporters.

References:

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