CBAA SEMINARS
2009

Membrane transport and regulation: How aquaporins regulate cell volume

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To survive under extremely diverse external conditions, the body must be able to maintain a constant internal environment, a process called homeostasis. Cell survival and function are only possible within a narrow range of physical and chemical conditions such as temperature, pH, oxygen concentration, osmotic and hydrostatic pressures. A major function of the cell membrane is the maintenance of an internal media and cell volume compatible with life, through the selective transport of nutrients, ions, and excretory substances between extracellular and intracellular compartments. The transport processes mediated by integral membrane proteins such as channels, carriers and pumps in plasma and organelle membranes are essential for physiological function. However, in spite of aquaporins being ubiquitary water channels among almost all life forms, their physiological role is not so well understood.

In this seminar, the common approaches to assess membrane transport will be described. A strategy that involves preparation of membrane vesicles from epithelial tissues to study epithelial transport from tubular organs (e.g. kidney, intestine), as well as from cell organelles, will be further detailed. Studies of isolated epithelial brush-border and basolateral membrane vesicles allow the composite permeability of the cell to be split into its component parts and yield more precise information about driving forces and about the role and regulation of transporters in epithelia. Using this system, a mechanism for volume regulation by membrane tension could be revealed in kidney proximal tubule, where massive solute and fluid transport occurs.

To further explore aquaporin regulation by membrane tension, we used yeast cells as a model that could bare surface tension some orders of magnitude higher than animal cells due to the existence of the cell wall. Experimental conditions were applied in order to create increasing levels of membrane tension and their effect on water channel activity was evaluated. As obtained for mammalian water channels, we found an impairment of aquaporin activity correlated with the establishment of membrane tension, corroborating the volume regulatory role of aquaporin in different cells.